Challenges to intermodal transportation – a case study

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Challenges to intermodal transportation – a case study

Abstract:

Purpose: The objective of the research is to identify the main challenges to intermodal transportation and discover the strategies to tackle them.

Methodology: The study collected data from two companies, with the first company being studied more intensively and the second one being used to verify the results. The data collection started by examining various company documents and then proceeded to conduct multiple interviews with employees.

Findings: The findings can be categorized into two categories.
The first category includes all identified challenges. The first big challenge revolves around terminal operators being hesitant to include intermodal transportation due to concerns around the technology. The second big challenge is the extremely low costs of driving on the road especially in Eastern Europe. The third big challenge is the lack of discourse in the public about the crucial role of supply chains in the emission of greenhouse gasses. This limits the appeal of intermodal transport.
The second category includes the identifies strategies. The first important strategy is to create partnerships between different companies operating in the intermodal sector. This helps significantly with strengthening the competitive situation of all companies involved. The second important strategy is to bundle knowledge and acquire relevant information and seek specialist knowledge when required. This helps to make the best possible decisions and increases the chance of success. The third strategy to increase the usage of intermodal transportation is to effectively communicate to customers and highlight the advantages of the business model.

Originality: This is one of the first studies to examine the two companies in the context of the challenges that there are faced with. This provides new data to look at the field of intermodal transportation and create a better understanding of it. It is also one of the first studies to examine potential strategies that are being used by companies in the field. The data generated here should help to provide more insight into how companies operating in this field could become more successful. This should help to make the entire field of intermodal transportation more competitive and lead to an increase in the usage of intermodal solutions.

Keywords: challenges to road to rail intermodal transportation, strategies to increase intermodal transportation, sustainable logistics

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1 INTRODUCTION

Many people that go into a store and buy a product might be wondering whether it is good for them and they might ask themselves how it was produced and under what conditions. The term sustainable consumption includes topics such as longer product life, sharing not owning, or less resource intensity (Middlemiss, 2018). Accordingly, many consumers have concerns about sustainability, and factors such as the country of origin are relevant factors that influence purchase decisions (Hinkes & Schulze-Ehlers, 2018). Consumers might think about the use of pesticides in the production of their food (Ghimire & Woodward, 2013). However, even people who think of themselves as being conscious of sustainability are most likely are not factoring in how the products were transported and whether this was sustainable.

According to recent figures by Eurostat, road transport holds the largest share of EU freight transport performance. In 2018, road transport accounted for three-quarters (75.3 %) of the total inland freight transport, which was an increase from previous years. In contrast, rail transport accounted for 18.7 % of the EU total (Eurostat, 2020).

In terms of sustainability, this is a significant problem since The European Environment Agency (EEA) states that road transport constitutes the highest proportion of overall transport emissions (around 71 % in 2018). Railway emissions constitute only a small proportion of overall transport emissions (below 1 %) (European Environment Agency, 2020).

According to Loske (2020), there is an increase in freight volume that is correlated to the number of new infections per day due to the COVID-19 pandemic. An attempt to understand this might be that since people in many places are not allowed to go outside for shopping or are cautious of the risk, they turned to online shopping and places such as Amazon to fill their needs. This then caused a higher volume of goods that need to be transported.

These figures and recent developments mean that there is an ever-increasing problem of transporting large volumes of goods in a more sustainable manner. The main options for reducing the greenhouse gas emissions of transport are reducing the carbon intensity of fuels, enhancing the energy efficiency of vehicles, shifting modes, and reducing demand (Vierth, et al., 2019).

(Kumar & Anbanandam, 2020a) have written about the fact that a more sustainable form of transportation would be to transport on rail and more specifically that intermodal freight transport services for the long haul are an effective way to reduce CO2 emissions and improve environmental performance. This means that the goods are in a container, which gets transported by ship and will then be put on a rail. The goods stay in the container for the entire length of the journey (Bontekoning, et al., 2004).

1.1 Research problem

Sustainable logistics is dependent on the accessibility of information in order to achieve a minimal use of resources. Therefore, it is necessary to gather data from different methods of transportation and connect them. It is important to have information about the number of emissions and the required use of energy for different forms of transportation. In order to have a sufficient network of transportation, there is a need to create an integrated system of transportation (Pfliegel, 2011).

Considering the climate change debate, sustainable solutions must be found to lower greenhouse gas emissions. Shifting transport from road to rail could help to achieve that. The company, which I will be interviewing, could make a valuable contribution here because it claims to represent a carbon-friendly method of transportation. Possible advantages are the reduction of fuel through the shift from road to rail, less waste of time through traffic jams, and less wear and tear on cars and roads (Randelhoff, 2010).

There is a lot of research on the advantages of intermodal transportation. (Oberhofer & Dieplinger, 2014) have written about how intermodal transportation has advantages regarding its ecological performance and helps to improve sustainability performance. The various sustainability challenges have been documented and a set of specific policies are needed to make improvements. (Kumar & Anbanandam, 2020a) have written about the importance of developing a policy instrument for the transportation sector and create sustainable strategies for tackling climate change, which can include supporting intermodal transportation. (Schnittfeld & Busch, 2015) have found benefits for the firms' long-term competitiveness when using sustainable transportation but also found that it is important to highlight the importance of sustainability on long-term development and on the firm's competitiveness.

However, there are many possible challenges that come with shifting freight between different modes of transportation and a lot of literature has been written about that. That is why my thesis will focus on identifying possible challenges in this area and analyze

where they might come from. However, there has been not so much written about how companies deal with these challenges and what kind of strategies they use. (Kim & Wee, 2011) identified the major elements of increased efficiency of the railroad. (Arnold, et al., 2004) looked at the impact of having locations of new terminals. (Baykasoglu & Subulan, 2016) created a model to minimize the total transit times and thereby achieve high customer satisfaction and minimize the total cost of the intermodal transportation system. That is why I will then try to gather data on how the company that I am interviewing is planning on dealing with those challenges.

Therefore, the topic of the thesis is Challenges to intermodal transportation – a case study.

1.2 Research aim (RA) and research questions (RQ 1-2)

RA: The research aim is to explore the biggest challenges to implementing an intermodular road to rail system and how they can be tackled.

RQ 1: What are the biggest challenges to implementing an intermodular road to rail system?

RQ 2: What are possible ways to tackle the different challenges and thereby increase the usage of intermodal transportation?

1.3 Delimitations

In this thesis, I am looking at two companies that operate in the field of intermodal transportation. I am only interviewing people who work for those two companies. The research is limited to five participants. I find this a big enough number to get enough inside into the field. Additionally, this delimitation originated from the fact that it is quite difficult to get access to data from high-impact sources without a personal connection. Since I have chosen to focus on those two companies, the thesis will only look at the geographical location in which they operate.

This main study is about one company, which is CargoBeamer. The sample is delimited to conducting all of the interviews with employees of CB. Therefore, a large part of the data will be from one source, which involves the risk of having a one-sided view of this topic. There might be sensitive information that the company is not willing to share or to see published. The study also excludes other companies that are active in the market and offer intermodular transport solutions.

The other company that I am looking at is Nikrasa. I will use the data to verify the data that I got from CargoBeamer and provide a more balanced view.

CB and Nikrasa mostly operate in Central and Eastern Europe, which means that the study is delimited to this geographical area. This can lead to overemphasizing issues that occur in this area and neglecting issues that might be more prevalent in other parts of the world.

I will try to address the limitations caused by the sampling strategy by not taking data from the interviews at face value and keeping a critical distance. I will analyze and reflect on how the interviewees perceive their current situation and the corresponding possibilities and challenges.

1.4 Definitions

Multimodal transport – multimodal transport is a combination of several shipping modes like the truck, rail, ocean, or air to deliver freight to its destination. Multimodal shipping suggests all your freight movements are handled under a unified bill of lading, even if different carriers are moving it (PLS Logistics, 2018).

Intermodal transportation - Intermodal freight transport is the movement of goods in one and the same loading unit or vehicle by successive modes of transport without handling of the goods themselves when changing modes (Bontekoning, et al., 2004).

Co - modality means the efficient use of transport modes operating on their own or in multimodal integration in the European transport system to reach optimal and sustainable exploitation of resources (Ambroziak, et al., 2013)

Synchromodality is an evolution of inter-and co-modal transport concepts, where stakeholders of the transport chain actively interact within a cooperative network to flexibly plan transport processes and to be able to switch in real-time between transport modes tailored to available resources. The shipper determines in advance only basic requirements of the transport such as costs, duration, and sustainability aspects (Karimpour & Ballini, n.D.).

Sustainability - the ability of one or more entities, either individually or collectively, to exist and flourish (either unchanged or in evolved terms) for lengthy timeframes, in such a manner, that the existence and flourishing of other collections of entities is permitted at related levels and in related systems (Oberhofer & Dieplinger, 2014).

1.5 Structure of the thesis

The structure of the thesis is that I start with the literature review, in which I present the important knowledge for this topic. Then I will present the methodology of the thesis including the research process, research methods as well as data analysis. Afterward, I will present my findings that I gathered through the interviews and with the help of additional documents. In the next part, I will connect the findings to the literature and discuss potential implications from the thesis and suggestions for further research. In the conclusion, I will talk about the bigger picture, implications of the findings, and the limitations of the research.

2 LITERATURE REVIEW

In this literature review, I will aim to explain the theoretical framework for this thesis. I will create a framework for the topic of intermodal transportation. This framework will then be used to create the interview guide for the empirical part of the thesis. Intermodal transportation has been studied quite a lot and from many different viewpoints. There is also a lot about the various challenges that exist in trying to increase the usage of intermodal systems. For this study, I want to summarize key literature regarding this topic and provide a comprehensive framework. However, I also want to focus on an aspect of intermodal transportation that has been studied far less, which is the strategies that companies can use to address possible challenges. Therefore, this literature review consists of two parts: challenges in intermodal transportation and possible strategies to address the challenges. At the end of the literature review, I want to summarize my findings and identify research gaps that will guide me in my interviews and which the work in this thesis aims to fill.

The used literature (studies, research, frameworks, and models) provides the academic basis for this research. This is necessary to have reliable and trustworthy results. I started my literature search by looking at the JUFO ranking and searching for highly ranked academic journals in the field of transportation. I used search terms such as intermodal transportation to get relevant results. In the end, I used articles from journals that had a ranking of either 2 or 3. I also aimed to have articles that are not older than 10 years. But I also used a few that were older since I found them to be of crucial value for this research. Additionally, I used the ABS Academic journal guide to search for additional research articles. I mostly ended up using articles that were in journals that had a 3- or 4-star ranking. I also used journals that were not just from the transportation sector but also from sectors such as regional studies, planning, and the environment since I found it important for this research.

2.1 Challenges to intermodal transportation

In this part, I will give an overview of the different challenges that are present in the field of intermodal transportation. I have divided this part into operational challenges, organizational challenges, and external challenges.

2.1.1 Operational challenges

This part includes all challenges that are directly connected to the operational part of intermodal transportation.

2.1.1.1 Crane deployment in container terminals

Intermodal transportation uses containers to transport fright. The containers are being handled in large terminals, which move millions of containers per year (Garehgozli, et al., 2015). The increase over the last decade in the number of containers that are being handled on each container terminal is starting to cause logistical concerns, particularly in large ports (Vis & Carlo, 2010). A container terminal consists of three areas: the quayside, in which containers are unloaded from and loaded onto vessels; the container yard, in which containers are temporarily put; and the gatehouse, which functions as the land entrance of the terminal (Chung, et al., 2002). The challenge lies in how container terminal operators can efficiently manage the logistic operations of the terminals and keep up with the increasing number of containers that must be managed (Garehgozli, et al., 2015). The operators must develop tools to deal with these massive volumes of containers and stay competitive (Vis & Carlo, 2010). A particular area of concern is the stacking area because most of the containers transiting through a container terminal must be stored for a specific period. Therefore, an efficient stacking operation is paramount to have a well-functioning container terminal (Garehgozli, et al., 2015).

There are several things to consider when analyzing the performance of terminals. The performance assessment of a container terminal is often dominated by the disembarking times of ships. This means that seaside containers are handled with a higher priority than landside containers. Heavy containers must be loaded before light containers and must therefore be moved first. All the trucks, trains, and ships arrive at the container yard at different times to either pick up or deliver containers, which limits the stacking and retrieving of containers. Container management must also work to prevent reshuffles, which are unwanted movements of a container, which is stacked on top of another. This container must then be retrieved, and this can put constraints on the operations of the terminal (Garehgozli, et al., 2015).

In this environment, one crucial issue is the deployment of cranes (Garehgozli, et al., 2015). To be efficient, operators need to address the problem of optimizing crane movements within different storage blocks in a container terminal (Chung, et al., 2002). This is true in the stack area because it is an interface in the terminal. To avoid the stack

becoming a bottleneck, it is important to examine new types of equipment that can be used in the stack and to develop new methods to schedule the equipment to efficiently handle all storage and retrieval requests (Vis & Carlo, 2010). One type of equipment that can be used is automated stacking cranes. However, there are multiple difficult operational problems arising in a container terminal, which are connected to the scheduling of automated stacking cranes (ASCs). These problems arise in the context of executing a set of storage and retrieval requests in a block of containers. Several practical and theoretical constraints must be considered: the ASCs cannot pass each other and, must have a safety distance in-between each other; each storage container must be stacked from a list of available open locations; and because of scheduling and different transport modes, containers are being assessed as having different levels of storage and retrieval priority. Researchers, so far, have only been able to solve the crane deployment problem to a high degree for small-size instances. This illustrates the complexity of the problem and the magnitude of the challenge (Garehgozli, et al., 2015). But recently, a container port in Hamburg has introduced a new technology with two ASCs working in a single block. These ASCs can pass each other, and as a result, they can cooperate in handling requests. They are also able to operate in the entire block. Researchers assumed that the workload can be equally distributed over both ASCs and tried to minimize the completion times for both cranes. They managed to come up with a calculation that minimizes the time that is also taking all technical characteristics of this ASC's configuration into account (Vis & Carlo, 2010).

2.1.1.2 Trailer assignment

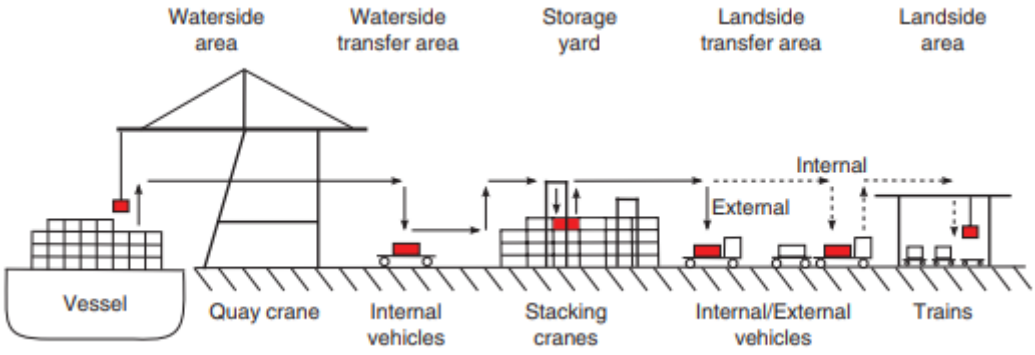
An intermodal rail company must minimize the costs of its terminals, outbound trains, while at the same time keep its service commitments, to be competitive. The most focus lies in minimizing the costs of outbound trains. These costs consist of the energy required to pull trains, costs associated with long-haul engines, and the costs of company-owned flatcars. One way to achieve this is by increasing the utilization of flatcars. Utilization is calculated by taking the percentage of loaded hitches versus the overall number of hitches. Loading more trailers on the same car increases utilization. But there are several restrictions when it comes to the combination of trailers that can be put on the same car. The different trailers need minimum clearance to comply with safety regulations. Also, the width of a trailer must not exceed the width of the railcar. There has to be a working distance between two trailers during loading and unloading operations (Feo & Gonzales-Valerde, 1995).

There is also the challenge of switching cars from a block. This requires time and usage of a switch engine and crew. Only a limited number of switching is possible. Researchers were not able to find an optimal solution for the assignment of trailers, even though they assumed unlimited switching capabilities. Therefore, new ways need to be found to increase utilization and minimize costs (Feo & Gonzales-Valerde, 1995).

2.1.1.3 Container dispatching

Another challenge lies in the container operations at a storage yard, which includes container dispatching and the previously addresses conflict-free crane routing problem. The design of a storage yard differs greatly in its handling equipment, its dimensions, and its automatic/nonautomatic processes. There are two main designs of a storage yard: layout parallel (i.e., Asian layout) or perpendicular (i.e., European layout). There are two types of containers. The first is import containers, which are to be picked up by a quay crane and transported to the dockside (See Figure 1). Then an internal vehicle transports the container to the storage yard where stacking cranes handle it stays before an external vehicle takes it or another internal vehicle transports it to the rail terminal. The second type is export containers, which is being transported from the landside to the waterside in reverse to the inbound container (Nossack, et al., 2018).

Figure 1 Container flow (Nossack, et al., 2018, p. 1060)



There are transportation requests from the waterside as well as the landside transfer areas, which are to be handled by the yard cranes. Every transportation request includes an origin and destination. The transportation requests stem from or end up at the storage yard. The terms inbound request and outbound request define the two different ways of requests. Inbound and outbound requests might also be called storage and retrieval requests. There are several challenges involved with container dispatching. These include in which order and by which crane the transportation requests should be carried out to minimize the makespan and prevent crane interferences. Researchers have made

several assumptions to try to solve this problem. One crane handles one container, all requests are being handled immediately and all cranes travel at the same speed. The results were that situations with up to 15 requests could have an optimal solution in moderate computational times. However, there is currently no solution for situations that involve way more than 15 requests. Therefore, there is a clear need for the development of sophisticated heuristic procedures for solving large-scale instances of container dispatching (Nossack, et al., 2018).

A particular big area of concern in container dispatching is the quay cranes. They are the most expensive handling equipment in port container terminals (See Figure 2). That is the reason why they often happen to be the bottlenecks for operations. Improving quay-crane efficiency should lead to a reduction in ship turn-around time, improvements in port productivity, and improvements throughout the freight transportation system (Goodchild & Daganzo, 2006). One approach to increase efficiency is to solve the dynamic berth allocation problem (DBAP) to minimize the distances traveled by the forklifts and the quay crane. This will be done for container loading and unloading operations and is trying to optimize their times. Researchers were able to achieve a reduction of operation times of about 10% using real data from a real port. While using scenarios that take future traffic increases into account, they were able to achieve a reduction in the maximum waiting time of 33% (Arango, et al., 2013). Another strategy for improving efficiency is called Double cycling. It is thought of to eliminate empty crane moves. It works by ensuring that containers are loaded and unloaded simultaneously. Therefore, it can double the number of containers that can be transported in one cycle. By making this type of improvement, port throughput should be increased, and the capacity problem can be successfully addressed. The problem lies in the fact that people who are not responsible for its implementation would benefit the most from it. This is limiting the usage and implementation of this technique. It would also need to be implemented in conjunction with other measures, as part of a larger infrastructural plan (Goodchild & Daganzo, 2006).

2.1.1.4 Aerodynamics

When talking about intermodal transportation, it is important to note, that it is, unfortunately, the least sustainable type of freight way train (Lai, et al., 2008b). To widen the usage of intermodal transportation presents a big challenge considering the increasing fuel prices and their percentage of operating costs. It is also bad since every government tries to support operations that conserve energy and reduce greenhouse gas

emissions (Lai, et al., 2008a). IM trains are the least fuel-efficient trains because of the physical constraints imposed by load configuration, placement, and railcar design (Lai, et al., 2008b). This can result in the aerodynamic drag coefficient of a typical IM train being 25% higher than a loaded coal train, and this gets even worse when increasing the speed of the trains (Lai, et al., 2008a). We must also note that despite this challenge there are opportunities to improve the aerodynamics of the trains (Lai, et al., 2008b). Researchers believe that the train resistance could be reduced by as much as 27% by better matching loads and railcars (Lai, et al., 2008a).

Currently, the slot utilization is not being perfected and IM cars are not loaded in a way that would maximize the energy efficiency of IM trains. Lai et al. (2008b) developed an aerodynamic loading assignment model (ALAM) with the objective to maximize aerodynamic efficiency of IM freight trains under several different combinations of loads and railcar types. With their model, it was possible to save fuel and reduce costs (Lai, et al., 2008b). The benefits can be further enhanced by better matching of railcars and loads for international intermodal trains, simultaneous optimization of multiple trains, and uncoupling empty railcars that are at the end of loaded intermodal trains (Lai, et al., 2008a). But they also noted that terminals operate in a dynamic environment in which information on incoming loads and trains is not always known. This reduces the potential of optimization. They proposed to address this by implementing a rolling horizon scheme with decreasing weight assigned to each train. This should provide a counterbalance to the uncertainty (Lai, et al., 2008b).

2.1.2 Organizational challenges

This part talks about the challenges that the organization is faced with to operate.

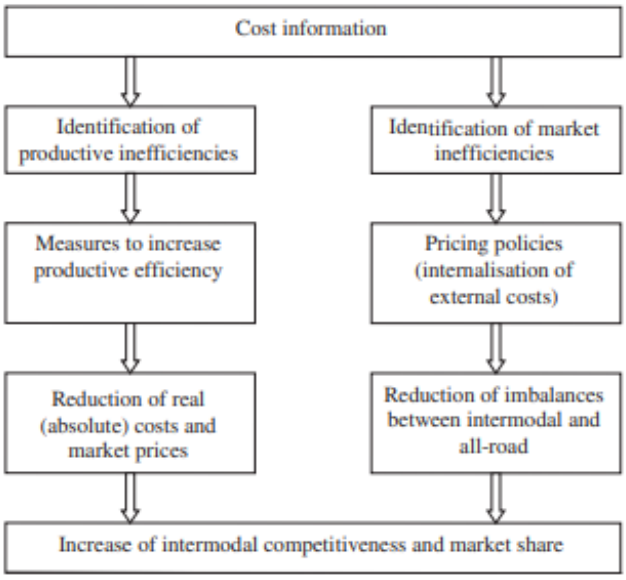
2.1.2.1 Pricing

One crucial issue in intermodal transportation is to set the appropriate prices for the use of operations. In fact, pricing decisions are among the most important things that determine the market position of a product or service. To maximize profitability, the decision-maker must manage the trade-off between increasing the prices to generate a profit and still be appealing to the intended target customers in an economic sense. Intermodal transport competitiveness is highly dependent on setting the right service tariffs and it represents one of the main weaknesses in the quest to generate economic success (Tawfik & Limbourg, 2019).

Li and Tayur (2005) have created a model for medium-term planning in the intermodal context that considers both the operations planning and the prices, which aim to maximize profits. They attempted to tackle the pricing challenge by seeing it as a concave maximization problem. Simultaneously, they also had to consider freight (trailer) routing, train routing, and train assignment. They used the assumption in their model that a customer selects a service not just based on the price, but also based on their evaluation of this service. Therefore, past experiences with the service are recalled, such as the actual travel time as well as any possible delays that have occurred before, and the urgency of the shipment. Researchers have concluded that medium-term planning in intermodal transportation might require a mathematical model that can calculate the global optimal solution and make an improvement to current practices (Li & Tayur, 2005).

Another issue that needs to be addressed when talking about pricing is knowing the exact costs of the service as well as the possible alternatives for customers. A company must have a competitive "market-survival" strategy. Freight service providers must do this by offering competitive contract terms and design their respective key schedules and routes, all while trying to achieve their economic and service goals. This is especially relevant for rail-based freight transport, where operators must accurately guess the expected demands of their customer shippers (Tawfik & Limbourg, 2019). But the intermodal industry operates in a highly volatile environment on the supply side as well. Daily intermodal demands are subjected to day-of-week patterns. Furthermore, the released containers from the demand origins are the new supply containers at the destinations. Every region is both the user and supplier of container capacity, which means that supply is intertemporally correlated. Additionally, transit time and customer equipment return time are stochastic, which means that internal controlled supply is extremely volatile. To have effective intermodal revenue management, any company must learn to operate in a changing environment on the supply, as well as on the demand side. Researchers have concluded that companies need a dynamic forecasting model that can handle the extreme volatilities in the industry (Luo, et al., 2016). But knowing the exact costs is also extremely important when it comes to policy formulation. This requires an in-depth knowledge of the costs of intermodal freight transport and of its driving factors (See Figure 2). Credible measurements of social costs (both internal and external) are a prerequisite for public policy as well as private strategy formulation to strengthen the competitiveness of intermodal freight services (Ricci & Black, 2005).

Figure 2 Cost information in intermodal transportation (Ricci & Black, 2005, p.247)



Major cost drivers in operations are 1. the unit costs of resources; 2. the efficiency of operations; 3. the load factors; 4. the length of a journey leg; 5. the characteristics of the journey leg; 6. the scale of movement (Ricci & Black, 2005).

Researchers have demonstrated the need to overcome the high fixed costs in freight transport. Further analysis needs to be conducted to derive a realistic cost division and enable companies to increase profits in intermodal transportation by using longer (and heavier) trains (Tawfik & Limbourg, 2019). Other possible strategies include increasing the number of wagons per train, reduce starting and stopping to save energy, increase the load factor, and improve the energy efficiency of locomotives (Ricci & Black, 2005). But researchers also concluded that even in a computerized best-case scenario, and even though intermodal transport would gain higher market share, it still would not be sufficient to satisfy the desired modal shift goals, set by the European Commission (Tawfik & Limbourg, 2019).

2.1.2.2 Planning and scheduling

Problems in the planning and scheduling of intermodal transportation revolve around unnecessary local inventories of freight cars, unsatisfactory level of responding to customer demands, and not having a distribution system in place that optimizes car movements. That is called an empty freight car distribution problem. It could lead to loss

of goodwill from customers or large costs for an unnecessary large fleet. It is therefore important to have a system in place that can satisfy more demand, while also utilizing cars that are not fully loaded and thereby increase efficiency in the system. This would greatly improve the distribution process. It would make it unnecessary to have safety inventories. It would also decrease the number of cars needed and thereby decrease costs (Holmberg, et al., 1998). It was deemed possible to achieve a minimum delay in the distribution of freight in the whole network and doing so by only mildly increasing transportation costs. Additionally, the extra costs of transportation can be compensated for by the reduction of the yard storage time, the waiting time for loading/unloading operations, etc (Febbraro, et al., 2016). Researchers were able to calculate a model that can also be adapted for various strategic purposes such as determining the value of better forecast. Things that still need to be done include creating a model that addresses a specific company includes uncertainties into the model. It also needs to change cost structure to the reality of economics of scale (Holmberg, et al., 1998). This might be achieved by developing a heuristic algorithm to provide a framework for large networks, which handle a very large amount of freight (Febbraro, et al., 2016).

Intermodal transportation also faces challenges that are connected to basic management and information limitations, which can cause poor train routes and schedules as well as inadequate priority rules for shipments. It is important that time and cost considerations in intermodal transportation are paid attention to since there might be additional delays occurring and there is an increased potential for mishandled containers at intermodal terminals. These challenges need to be addressed to be able to compete with long-haul trucking (Newman & Yano, 2000). Economic efficiency and quality of service are the interdependent contributors to the competitiveness of intermodal transportation (Febbraro, et al., 2016). Researchers addressed this by looking at how to schedule direct and indirect trains as well as for deciding on which containers to send on each train for the rail (linehaul) portion. This was done to try to minimize operating costs while fulfilling on-time delivery expectations. Additional problems are the widespread terminals for intermodal transportation, the few terminals in use, and there is a greater expectation from customers for service (Newman & Yano, 2000). Intermodal freight transportation systems are mostly geographically distributed, it is, therefore, difficult to create a central coordinator, who takes charge and coordinates the entire system. It might be useful to look at decentralized optimization approaches to tackle this problem. This would mean that the system is split into several sub-systems which are optimized individually (Febbraro, et al., 2016). Researchers have tried to address this problem, but

several aspects need to be solved sill. These include incorporation of hub capacity, intermediate hub scheduling, origin scheduling, and dealing with multiple rail segments (Newman & Yano, 2000).

Another challenge is to respond to worldwide demands, which means that container terminals need to efficiently unload, load, and conduct transshipment operations. This includes solving several decision problems. These include the development of planning and control concepts for all the systems that are being used in the terminal. A major planning problem is calculating the minimum number of vehicles required under time-window constraints. Researchers found out that using one or two vehicles fewer than the value obtained with simulation results in only a small increase in the unloading times of the ship. They also found out that increasing the cycle times would lead to a lower number of vehicles required (Vis, et al., 2005). Connected to this is the classical vehicle routing problem, which consists of planning and scheduling for the transport of unit loads. Unit-load transport means that each load requires its own vehicle for transportation. The vehicle routing problem has two major parts: the assignment of transport requests to vehicles and the scheduling of the requests for every single vehicle. All the assigned requests should be done sequentially. As a result, the next load can only be picked up for transport after the previous load has been delivered. Routes consist of alternating sequences of loaded rides to perform transport requests and empty rides to perform trips to the next starting point. Researchers have shown that creating an algorithm to calculate the shortest directed multiple-row storage as well as a tour to perform all requests is leading to a much better performance than the traditional first-come-first-serve approach (Vis & Roodbergen, 2009).

Some seaports such as Los Angeles and Rotterdam, have implemented so-called “dry ports”. In these ports, containers are not stacked at the deep-sea terminals but rather they are being transported in bulk to hub terminals positioned inland. This reduces congestion at the sea terminal as containers remain there for less time. When a large volume of containers needs to be transported it makes sense to use a river vessel or train, which ensures the frequency of service, while also decreasing the impact on the road infrastructure in the port area. River vessels and trains, however, have longer transit times, and the river and train networks often only connect to a small number of destinations. Another disadvantage is often that containers need to be transported on time and vessels or train schedules do not allow for this. There is also uncertainty in the planning about the times the containers are available for transport and the transit times.

The planning of containers is currently mostly conservative, with slacking times build in to ensure arrivals on time. Providing more information may therefore reduce uncertainty, make slacking times unnecessary and thereby enhance performance. Information technologies could play a crucial role in increasing intermodal freight transport. But quantitative models are needed to increase information in freight transport and create an intelligent transportation system. Researchers have used Pareto frontiers to assess the value of information expressed in terms of efficiency and reliability. A Pareto optimal decision was to deploy a barge very late to reduce costs while having to accept a low level of reliability. Another Pareto optimal decision happened to be transporting containers by truck and thereby have high reliability while having to accept higher costs. The Pareto frontiers describe a strategy to create optimal balances in the trade-off between reliability and efficiency while admitting that not all desired outcomes can be achieved at the same time (Zuidwijk & Veenstra, 2015).

2.1.3 External challenges

This part is about the external challenges that impact the operations of the organization.

2.1.3.1 Natural disasters

Due to climate change, the risk of natural disasters has dramatically increased (Chen & Miller-Hooks, 2012). Because our infrastructure systems are complex, interdependent, and interconnected, a disruptive event to one system can cause multiple systems to fail or make for a difficult recovery (Faturechi & Miller-Hooks, 2014). Therefore, trucking companies, rail carriers, infrastructure managers, and terminal and port operators must step up and increase their efforts to prevent or mitigate the effects of disasters. Even small incidents, such as the derailment of cars from tangent track, can cause network disruptions, which leads to bad service and severe delays (Chen & Miller-Hooks, 2012).

One key characteristic of a secure transport network is its ability to recover from disruptions. This resilience is dependent on the network structure as well as activities that preserve or restore service in case of a disaster (Chen & Miller-Hooks, 2012). To choose the best investment options that can reduce the risk of failure and increase a system's ability to rebound, one must be able to quantify the innate ability of the system to cope with disaster. One framework that could be used to show to agencies is the infrastructure protection framework (See Figure 3). It was developed with an objective to maximize system performance given budget and recovery period limitations (Faturechi & Miller-Hooks, 2014).

Figure 3 Infrastructure protection framework (IPF) (Faturechi & Miller-Hooks, 2014, p. 574)

Research has shown that post-disaster activities can drastically improve resilience levels and mitigate the negative effect of disasters. Recovery activities have been shown to be critical to a network's ability to recover and must be kept in mind. Furthermore, other measures such as reliability and flexibility are likely to underestimate the network's ability to cope with unexpected events and are not suited to predict resilience. There has been no model so far that considers long-term recovery and reconstruction. This would require a dynamic network model where capacity is recaptured over time to reflect changes in network performance as post-disaster conditions begin to improve (Chen & Miller-Hooks, 2012).

2.2 Potential inhibitors for wide-scale adoption of intermodal transportation

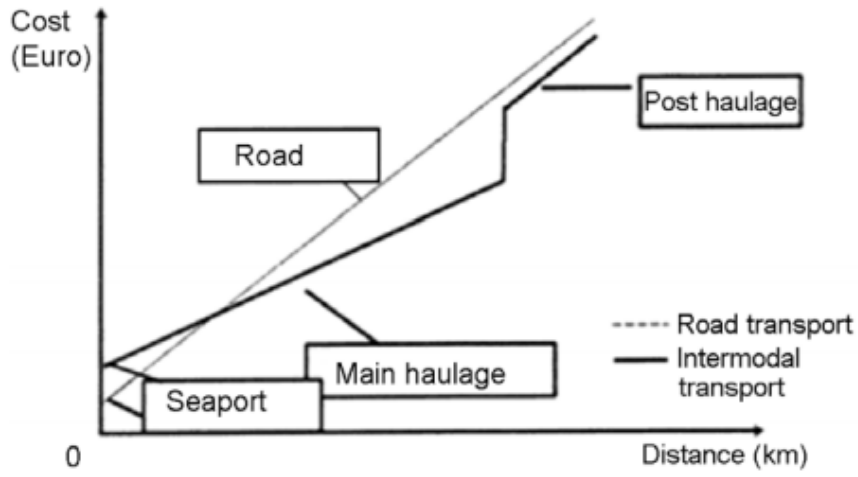
In this part, I will lay out what are the crucial elements that need to be paid attention to when thinking about the wide-scale adoption of intermodal transportation. Each of the respective inhibitors presents its own set of challenges, which need to be acknowledged.

2.2.1 Legislation

To strengthen intermodal transportation, it is crucial to have the right kind of policy measures to lend support (Macharis & Pekin, 2009). In fact, many governments have made the modal shift from unimodal to intermodal transportation part of their plan to reduce the negative fallout from freight transport (Kumar & Anbanandam, 2020b). The promotion of intermodal transport is, for example, a key objective in European Union policies (Tsamboulas, et al., 2007). But to achieve this, institutional challenges need to be recognized that hamper the development of intermodal transportation (Kumar &

Anbanandam, 2020b). It has been acknowledged that intermodal transport has certain difficulties in competing with unimodal transport, which is a problem that mostly presents itself over short distances (See Figure 4). It is also negatively affected by the high fixed costs from the handlings in the inland terminals (transshipment from barge to quay and onto a trailer) (Macharis & Pekin, 2009). If governments are serious about supporting modal shift, they will need a good understanding of why transport partners and decision-makers make certain mode choices (Kumar & Anbanandam, 2020b).

Figure 4 Cost structure (Macharis & Pekin, 2009, p. 501)



The situation right now is that barge terminals further away from ports have a larger market area than the ones that are closer. This makes sense since, over the longer distance, the lower variable costs can compensate for the higher costs for handling in the terminals (Macharis & Pekin, 2009). On the reverse, short distances and a small volume of freight transport are a hindrance to intermodal rail-road transport. The break-even distance for intermodal rail-road transport is currently put at 600–900 km. Also, the mode changing at the terminal is a critical cost factor as it increases total transportation cost (Kumar & Anbanandam, 2020b).

Policy measures that would help strengthen intermodal transportation could be directed towards reducing the high fixed costs, as well as provide support for the building of new terminals or increase support for the already existing ones (Macharis & Pekin, 2009). That is because a limited rail infrastructure in remote locations restricts the flexibility of the rail mode (Kumar & Anbanandam, 2020b). Policies that are broad and general tend to not improve the competitive position of intermodal transport very much, since they

fail to take the attitude of private stakeholders involved in the transport supply chain into account (Tsamboulas, et al., 2007). Research has shown that it would be helpful to have a more integrated policy approach to create a model shift from barge to rail as opposed to the scattered policy initiatives that exist now. (Macharis & Pekin, 2009). One example that could give orientation is TRILOG, which is part of the wider OECD framework and part of the EC's transport program. It was created to provide an overall vision of what policy actions the EU can take. As a foundation for policy measures, it is important to assess the competitiveness of intermodal transport within specific regions and identify the regions, in which it can be competitive to road transport (Tsamboulas, et al., 2007). Public expenditure in the transport sector needs to be used to promote interconnectivity and interoperability between urban public transport and nonroad (rail, seaport, and airport) transport modes and between seaports and railways. Policymakers need to account for the intrasectoral benefits of each transport investment and subsidize projects with large positive fiscal externalities (Tsekeris, 2011). Intermodal transportation has provided many peripheral regions with better access to business opportunities (Lim & Thill, 2008). This could serve as an additional argument for drafting legislation that strengthens this mode of transportation.

2.2.2 Infrastructure and technology

Intermodal transportation faces several shortcomings that are connected to the existing infrastructure and technologies (Konings, 1996). In infrastructure, there are challenges related to efficiency, operating costs, and reliability. In technology, there are challenges related to containerization, automation and robotics, handling and interchange systems, automated terminals, information systems, efficiency and reliability, and potential new opportunities (Rodrigue, 2006). As Yamada et al., (2009) have identified, most of the port terminals only offer very low levels of service since they are lacking in berths and supporting equipment. This is one of the reasons why the current infrastructure is not optimally developed to ensure well-coordinated and efficient multimodal operations. New roads, railways, sea links, and freight terminals need to be built or the existing ones need to be improved (Yamada, et al., 2009). Improving linkages can offer benefits to firms in central as well as peripheral regions because of reduced shipping costs. Whether they can take advantage of that depends on wider socioeconomic factors. There might also be the danger that because they now competing with firms from the center, they will be not competitive and vanish (Lim & Thill, 2008). It is important to carefully select infrastructure projects to achieve an efficient design of the multimodal freight transport network. Models need to be created to find optimal solutions and establishing the

relationships between the optimal location and transport cost. The challenge to develop such a model lies in the fact that it will need to account for the fact that the improvement of link capacity and the addition of new links to an existing multimodal transport network will significantly change and improve the workings of the network (Yamada, et al., 2009).

As Konings (1996) has identified, intermodal transport does not always offer a high amount of reliability and its transit times are too long. That is because there are extra links in the chain of intermodal transport. While improvements have been made, the junctions where one mode of transport must adapt to another still exist. Another challenge is that with the increasing demand that is put on handling technologies at terminals, transport arrangements become more critical. The growth of intermodal transport can threaten the accessibility of the terminal in which mode changes are happening. Therefore, cost savings and quality improvements in handling systems must be developed (Konings, 1996).

Researchers have found that improvements in the areas of road widening at heavy-loaded links and seaports could be better than developments of new roads and rail links. Road widening in heavily congested areas and seaport improvements could help to establish transport corridors across countries (Yamada, et al., 2009). The researcher has also found that integrated centers for the Transhipment, Storage, Collection, and Distribution of goods (TSCD) could help at large freight distribution handling terminals, which have congestion problems. When freight volumes are large enough, it makes sense to look at automation of transport and handling, but this type of automation can be expensive and might not be worth the investment (Konings, 1996). However, since transport systems are becoming more global, distribution capabilities must be able to deal with different freight-mobility needs such as predicted or unpredicted demand (Rodrigue, 2006). This fact could then be used to justify investments to increase automation.

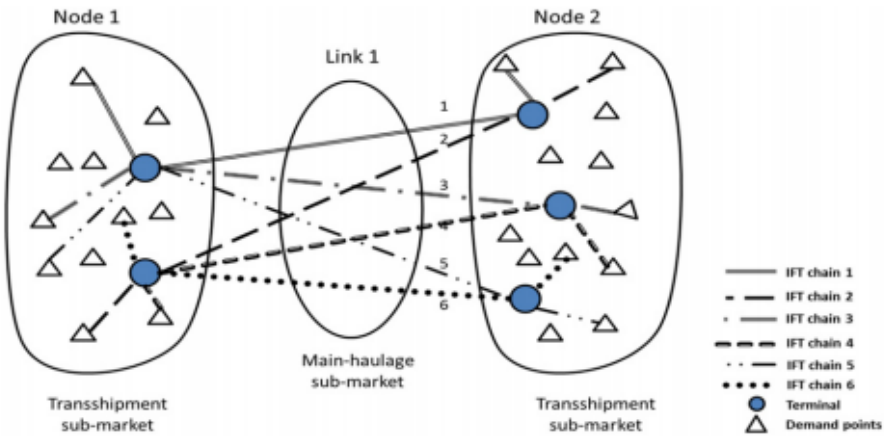
2.2.3 Competition

Another potential inhibitor of wide-scale intermodal transportation is competition. There are two challenges to determine the competitive landscape for the European intermodal network. The first challenge is to define which inland terminals are potentially competing for a specific service demand. That is to determine if a market is a competitive market. The second challenge is getting detailed data on the capacity of each

transport operator along different routes, which has been proven to be very difficult (Saeedi, et al., 2017). Improving the intermodal transport usage depends on increased competitiveness and possibly entering new markets. It also depends on performing well in several critical criteria: freight rates, carrier considerations, transit time, shipper market considerations, and safety (Reis, 2014). Distance and time are important to consider. They impact transport costs. Vehicle distance generates vehicle distance costs and time. Vehicle time generates vehicle time costs (Kreutzberger, 2008).

To give a concrete example imagine a shipper that wants to transfer containers from Rotterdam (Netherlands) to Verona (Italy). The shipper has many options to choose from that can arrange for transport and handling. They differ in pre-haulage, transhipment, main haulage, and end-haulage services. One option is to hire one of the many truck companies to transit containers from the shipper's location to one of the terminals in Rotterdam. Furthermore, there are many options for transshipment services and different terminals in the area (the Rail Service Center, ECT Delta). Afterward, there are many options to choose a corridor to transport the containers from a terminal in Rotterdam to a terminal in Verona. It is important that the corridor is competitive (cost and quality), and directly (or indirectly) connects a particular terminal in Rotterdam to a particular terminal in Verona (See Figure 5). Within one corridor are different rail and barge operators (also called the main haulage) In the end, there are many options to choose an end-haulage operator out of a large number of truck companies inside the end-haulage submarket (Saeedi, et al., 2017).

Figure 5 Different submarkets inside a corridor (Saeedi, et al., 2017, p. 142)



Some rail operators in France (SNCF FRET), Belgium (B-Cargo), Germany (DB), and the Netherlands (PRORAIL) have started to offer Long Intermodal Freight Trains (LIFTs)

as a more efficient alternative to Conventional Intermodal Freight Trains (CIFTs). The aim is to improve competitiveness within the rail sector and increase the competitiveness of rail with respect to road freight transport in the corridors between Northern- and Southern Europe. Despite achieving a competitive advantage by using LIFTs (Janic, 2008), researchers have done hypothetical scenarios in which intermodal transport competes with road transport. The results showed a clear advantage for road transport. In fact, intermodal transport only outperforms road transport in some of the scenarios in the price variable. Consequently, in most scenarios, there was little reason to choose intermodal transportation (Reis, 2014). Researchers also found out that costs are more important for customers of intermodal transport than time or frequency. Nevertheless, customers of road transport put a high value on the time competitiveness, which means that to widen the usage of intermodal transportation it is paramount that it is competitive regarding both costs and time (Kreutzberger, 2008). Therefore, intermodal transportation will only be economically viable if a reduction of the generalized impedance on modal segments offsets the higher costs (Lim & Thill, 2008).

2.3 Strategies to tackle the challenges and address the inhibitors

In this part, I will summarize two common strategies that are being employed to tackle some of the challenges and address the inhibitors that have been mentioned in the previous part and try to widen the usage of intermodal transportation. This first strategy revolves around cost analysis while the second strategy is about optimization and improvements.

2.3.1 Cost analysis

As mentioned in the previous part of this literature review, the economic feasibility of intermodal freight transportation is one of the crucial factors that determine the scale of usage (Kim & Wee, 2011). A generic model of calculating the costs of intermodal transportation can be found below (See Figure 6) (Janic, 2008).

Figure 6 The full cost of the intermodal transport system (Janic, 2008, p. 1332)

- ***Internal cost:***
  - Transport cost = (Frequency) × (Cost per frequency)
    = [(Demand)/(Load factor × Vehicle capacity)] × (Cost per frequency)
  - Handling cost = (Demand) × (Cost per unit of demand)
- ***External cost:***
  - External cost = (Frequency) × (External cost per frequency)

The transportation industry does not focus on the environmental advantages of intermodal transport systems. Economic competitiveness is still the main deciding factor (Arnold, et al., 2004). Therefore, it is very is important to correctly calculate the break-even distance of the transportation mode to make it attractive to the cost-saving-oriented shippers. This task is very difficult because it is determined by multiple factors, such as long-haulage rail distance, truck-only distance, long-haulage rate, truck-only rate, transshipment rate, detour factors, and terminal locations. That is why researchers have focused on analyzing which factors are heavily important to decreasing the break-even distance. They found that the major elements were increased efficiency of the railroad, higher utilization rate of train space and higher size of containers, increased length of a train, introduction of double-stack technology, introducing new transshipment technology, and rising fuel prices (Kim & Wee, 2011).

Results have shown that geometric factors (distances) and terminal handling costs are less significant than transport costs (i.e., rail costs and long-distance trucking costs) when it comes to increasing intermodal transportation (Kim & Wee, 2011); (Kurtulus & Cetin, 2020). This is important for policymakers since it gives evidence to the fact that increasing truck rates, e.g., by adding taxes, seems to be the most effective policy to increase the intermodal mode share. On the other hand, things like reducing drayage and terminal cost are not significant (Kim & Wee, 2011). The location of new terminals will not drastically increase the market share of combined traffic, and a relocation of existing terminals to achieve transport cost minimization has little impact (Arnold, et al., 2004). However, there is no agreement in the literature if measures that are aimed at reducing intermodal transportation costs, as well as policies that promote intermodal transport, are more effective than policies to discourage road transport. It is also debated if increases in the cost of road transport are more significant than reducing the cost of intermodal transport (Kurtulus & Cetin, 2020).

Another important point to consider is that certain costs are being put on the society to handle (e.g., air pollution costs). This should also be taken into consideration when analyzing cost structures. There are also certain benefits from using a particular type of transportation. This can include the value of community pride in a transit system, impacts on community liveability, and access for the socially and economically disadvantaged. But those things are difficult to monetize and are often forgotten when it comes to decision making. Cost analysis tools must find a way to take all those into account when trying to make a wholesome decision (DeCorla-Souza, et al., 1997).

2.3.2 Optimization and improvements

To be economically competitive, intermodal transportation must optimize the flows of flatcars under constraints that dictate the assignment of trailers (See Trailer assignment problem). This could help to reduce costs by maximizing utilization (Powell & Carvalho, 1998). As mentioned previously (See Pricing) load planning is important to reduce costs. This can be done by using a novel mixed-integer mathematical programming model, which solves multi-objective, multimode, and multi-stage periodic load planning or intermodal freight transportation planning problems. This proposed model includes multiple essential sub-problems such as transportation mode and service type selection, outsourcing, periodic load allocation, consolidation at the transshipment seaports/rail stations, usage of block trains and public trains with fixed or flexible time schedules, etc. Additionally, to minimize the total cost of the intermodal transportation system, this model tries to minimize the total transit times and thereby achieve high customer satisfaction (Baykasoglu & Subulan, 2016).

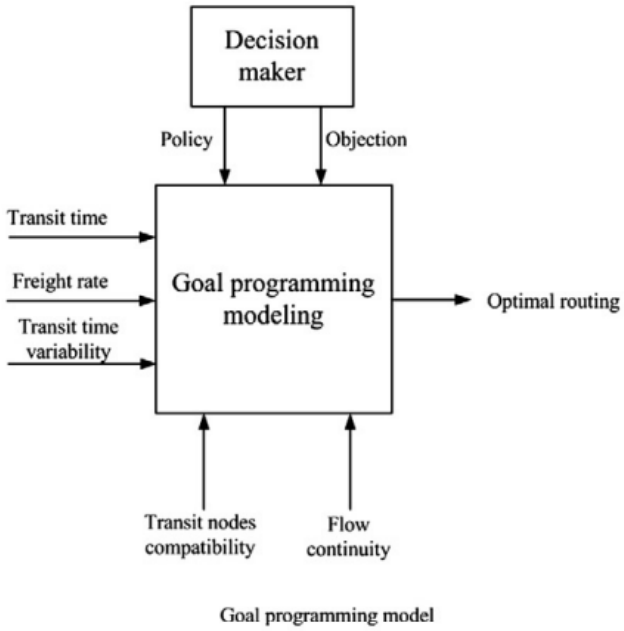
Optimizing flatcars and route calculation are also connected to the problem of incomplete information (See planning and scheduling) Constraints are often used to represent incomplete information to describe relationships between partially undetermined objects. To address this fact, it might be useful to introduce constraint logic programming (CLP), which would allow to include a statement of constraints in the body of clauses. This could help to overcome some of the methodological and logical problems associated with traditional ways of modeling. Research has shown that it has micro-and macro consistency (Heinitz & Liedtke, 2010).

Another way of dealing with the problem of route planning is to employ dynamic vehicle route panning (DVRP), which uses inputs, such as time, cost, load, and demand. It constantly receives and updates information in line with the determination of the route. DVRPs can cope with real-time (online) requests and/or demands. Researchers have also developed a variation that minimizes greenhouse gas emissions using a model of intermodal freight transport. This can be used to show the potential of intermodal freight transport for reducing greenhouse emissions to legislators. It could convince governments to put less tax on routes with lower emissions, which would strengthen intermodal transportation (Liao, 2017).

To achieve an optimized intermodal network, it can also be useful to implement goal programming (See Figure 7), which stems from the field of multiple-criteria decision-

making (MCDM). Researchers have applied this method to investigate the relative attractiveness of competing routes under different priorities and demands for speedy delivery, safety, and reliability. Additionally, they did sensitivity analyses to examine the sustainability of competitiveness of routes under changing conditions that are relevant to shippers, logistics providers, and policymakers (Yang, et al., 2011).

Figure 7 Intermodal network optimization model (Yang et al., 2011, p. 518)



As mentioned previously (See Competition) intermodal rail to road transport cannot compete with truck service over short distances. But research indicates that the competitiveness of intermodal transport could be improved if transshipment were faster and less expensive because they are relatively high for short distances and diminish competitiveness. Therefore, improvements in reliability and flexibility of intermodal transport in form of a substantially better cost to-quality ratio must be made. Intermodal transport must serve more transport flows on relatively short distances, and for small flows. Researchers have experimented with the idea to implement innovative bundling models and new-generation terminals to integrate small flows into the intermodal system. However, by looking at a few case studies there was no clear evidence for advantages occurring. But researchers noted that more case studies are needed to make a definitive judgment on this (Trip & Bontekoning, 2002).

2.4 Theoretical framework

In the literature review, I have given an overview of multiple challenges that are being discussed in the literature as well as some of the possible strategies that can be employed to address these challenges. As noticed in this chapter, challenges in the field of intermodal transportation can come from a diverse set of issues. There is the issue of setting the correct prices, which is connected to the proper calculation of costs. There are issues with crane deployment and trailer assignment, which are more technological challenges. There are a lot of challenges connected with the correct planning and scheduling of transportation, which connects to problems with infrastructure.

All these challenges impact the competitive position of intermodal transportation. That is why policymakers must craft legislation that correctly identifies relevant problems and addresses the relevant challenges. Only then it is possible to strengthen the competitive situation of intermodal transportation.

Regarding possible strategies to tackle challenges, I have identified two common ones, which are cost analysis and optimization and improvements. Since this is an under-researched area there wasn`t much more literature on this part. This represents a gap in the literature. The second part of this thesis will therefore aim to provide a clearer picture of what strategies a company can employ to address challenges. It will also try to shed a light on which of the challenges are the most crucial ones or might also offer another set of challenges that so far have not been getting much attention previously in the literature. In the next chapter, I present the methodology used for this thesis.

3 METHODOLOGY

In this section, I will lay out the methodology chosen for this thesis, my process of data collection as well as data analysis. I will give the reason why I have chosen to proceed the way I did. Additionally, I will give more information about the members of the organization that I chose to interview.

3.1 Research Design

The research design for this study is a case study. A case study puts an emphasis on generating detailed and holistic knowledge (Eriksson & Kovalainen, 2008), which I find very important. The results are based on the analysis of multiple empirical sources, which makes it heavily contextualized. Furthermore, case study research intends to leave room for diversity and complexity and, as a result, stays away from exceedingly simplistic research designs (Eriksson & Kovalainen, 2008). In our increasingly complex world, the features of a case study should help to break topics down and make them understandable without trivializing them. A case study is a necessary and sufficient method for specific important research tasks, and it is a method that holds up well when compared to other methods in the scope of research methodology (Atkinson & Delamont, 2010).

The study will generate qualitative data acquired through semi-structured interviews as well as additional documents such as the company website, explanatory videos, and company presentations. This study can be considered exploratory and inductive. I use an exploratory study since this is the best option to use when researchers are not entirely sure what categories, links, and perspectives are important. I use an inductive study because I aim to produce generalizations through analyzing a series of cases (Seale, et al., 2004).

I recognize that inductive generalizations are always uncertain, and vulnerable to further research which may prove inconsistent (Seale, et al., 2004). However, since the technology that the case company is using is new and there is very little literature about it, I deem it very important to research it even if other technologies in the field might encounter a different set of challenges or the companies use different strategies.

3.2 Research Method

For this thesis, I interviewed several employees of CargoBeamer. I chose to conduct in-depth interviews with them to gather empirical data. By having multiple employees, I make sure that the information is more accurate, convincing, diverse, and rich. It also

allows me to triangulate from multiple sources and therefore provide a more multidimensional image. Since every single source has strengths and weaknesses, I aim to balance the weaknesses out by having multiple sources (Eriksson & Kovalainen, 2008).

I decided to conduct semi-structured interviews since I wanted to use my readings of the literature as the foundation for the questions, but I wanted to also have an opportunity for new questions to emerge. This was important because one area is under-researched, so new information is likely to come up during the interviews. I also thought that semi-structured interviews would provide me with an opportunity for development within this study and was wells suited to producing new substantive insights (Seale, et al., 2004). I used this method in the online interviews, which I conducted. I had to rely on doing interviews over online platforms rather than face to face interviews out of necessity. Due to the COVID-19 pandemic in 2020, I would have not been able to fly from Finland to Germany and back without having to quarantine twice. I also didn`t want to put any of my interviewees at risk. I, therefore, decided on online interviews as a suitable alternative.

I formed my interview questions so that they connect to my research questions and overall research aim. I started with questions about basic information and the positive side of the company and their technology to ease my interviewees into the interviews. I then became more specific and started to ask more questions about the problems that they are faced with. In my interview structure, I tried to encompass all relevant aspects and give each interviewee the chance to present their specific knowledge. It was important to me to ask everyone the same questions initially to have a chance to triangulate the given information later.

The interviews were carried out over the time of one month, which was dependent on the availability of the persons. The first person that I interviewed was the founder and CEO of CargoBeamer (See Table 1). This was important since he was my initial conduct and I relied on his network to get other employees as interview partners. I also believed that after interviewing him, he could guide me to the most useful people that I should be interviewing. All the interviews were conducted in German as this was everyone's mother tongue. Furthermore, I believed that this would help everyone to feel at ease and not to worry about mistakes in understanding or in their expressions. This should help to focus on information and the topic and provide me with better insights.

Table 1 Interviewees

Interviewee	Organization	Duration	Date
CEO	CargoBeamer	47:53 min	27.10.20
Director of Business Development	CargoBeamer	47:21 min	05.11.20
Mechanical engineer	CargoBeamer	43:50 min	12.11.20
Employee of controlling division	CargoBeamer	34:50 min	17.12.20
CEO	Nikrasa	55:13 min	27.01.21

In addition to the interviews, I also analyzed documents that I was given by the company and that I sought out on my own. A list of these documents can be found in the table below (See Table 2).

Table 2 Documents

Type of document	Name of the document
Website	CargoBeamer
Video	How CargoBeamer can bring sustainability to Logistics and solve the Gridlock
Video	LG Cargo, PKP Cargo and CargoBeamer team up to pilot semi-trailers train
Video	Messefilm CargoBeamer 2014

Presentation	CargoBeamer Emissions- und staufreie Güterlogistik der Zukunft
Presentation	CargoBeamer Next generation rail freight logistics Overview
Report	Handbook on the external costs of transport Version 2019
Website	Logistik Innovativ
Video	Best-off Logistik Innovativ
Website	TXlogistik

3.3 Research Process

As mentioned previously, the research process involved data collection that was done by conducting semi-structured interviews. Since this is a case study, I interviewed several employees from my focus company. I started with the CEO of the company since I relied on his network of contact to help me schedule the other interviews. The interviews were conducted online and each one was done in one sitting. The total number of interviews is expected to be 5. The full research process is described below.

1. Set topic and research aim
2. Review literature about intermodal transportation and identify research gaps
3. Create an interview guide based on the reviewed literature
4. Conduct interviews with employees of CargoBeamer by using the interview guide
5. Analyse the interviews and interpret the data
6. Connect the collected data to the reviewed literature to fill the identified research gaps
7. Validate data by using the findings from Nikrasa

3.4 Data collection

In this section, I will lay out the plan, which I follow to connect the data for this thesis.

3.4.1 Sample design

Since this case study is of exploratory nature and aims to be an intensive case study that emphasizes interpretation and understanding of the case (Eriksson & Kovalainen, 2008), I decided to conduct interviews, and this was to be the qualitative study method. It is important to receive information on intermodal systems from people who work in the industry because literature does not yet provide all the required knowledge and still has under-researched areas. For this case study research, it was important to use critical case sampling, which looks for units representing the most relevant cases for transfer of findings to other related cases (Eriksson & Kovalainen, 2008). Since the employees of the company that I was interviewing have extensive expertise in the field of intermodal transportation, I found them to fit this purpose extremely well. I also decided to keep the number of interviews relatively small because I believe that the incremental contribution of additional cases would only be marginal (Eriksson & Kovalainen, 2008). Deciding on doing five interviews with highly relevant sources, should therefore provide me with sufficient data without running the risk of having multiple interviewees giving the same information, which would make it redundant and contribute nothing to the research. It should also allow me to stay inside the scope and timeframe of this research project.

For this research, I will be using a snowball sampling strategy. This means picking several subjects who possess compulsory characteristics and, via their recommendations, finding further subjects with the same characteristics (Seale, et al., 2004). For this research, the interviews will be with employees of CB since those are the interviewees which should enable me to acquire new and up-to-date data and provide me with great insight. The first interviewee will be the CEO of CargoBeamer since he is the founder of the company and therefore a highly valuable source. Through personnel connection, I can ensure access to this source. He has already and will continue to give me suggestions for which employees will be most suited for the study to provide relevant data. Those employees will then be contacted and interviewed. This sampling strategy ensures that the data is relevant and that the interviews can provide the necessary information to answer the research questions.

3.4.2 Company profiles

CargoBeamer is a company that operates in the combined transportation road-rail sector in central Europe and is based in Leipzig, Germany. It uses a horizontal loading technique that enables a fully automated loading process of all wagons of a train at the same time. This process does not need additional conversations or reinforcements. Since 2015 the company operates on a route between Northern Germany and Italy and has transported the equivalent of more than 70000 truck journeys.

Nikrasa is a company that employs a technology that enables them to move trailers which up to now could not be loaded on trains to be moved from the road onto the rails. They currently work with around 100 transport platforms. Nikrasa transports around 4,000 trailers on routes between Padborg and Verona, Herne and Verona, Herne and Budapest, and Bettembourg and Trieste.

3.4.3 Execution of interviews

The interviews were arranged with one interviewee at a time via email since I did the first interview with the CEO and he then suggested to me the next possible interviewee. The interviews were conducted over Microsoft Teams and I audio recorded them. Based on the recording, I translated the interview from German to English and did a transcript of the entire interview afterward. Additionally, I took some field notes during the interview to help me ask further questions at the end of the interview. The interviews were semi-structured, non-standardized interviews, as they fit the nature of this research. The duration of each interview is so far at about 48 minutes. Because each interviewee has different expertise, I asked additional questions during the interview as I saw fit to do and in relation to various influences. I adjusted my list of questions in relation to the specific person I was interviewing (Seale, et al., 2004). The interviews were carried out with a list of questions according to the interview guide (See Appendix 1) since it was useful to have something with me that provides orientation and guidance for the interview (Seale, et al., 2004). At the end of the interview, I asked an open question to give the interviewee a chance to say something that was important to them and provide me with additional data in a more flexible setting.

3.5 Data analysis

Once I will have collected all the data, transcribed the interviews, I will analyze it. In the beginning, I will be coding the data. This means that I will organize and label the empirical data. This already includes interpreting the data in a systematic way (Eriksson

& Kovalainen, 2008). Since my research revolves around the themes of challenges and strategies, I plan to use these two points as thematic focal points. I believe this is the appropriate way to conduct this research, since my case study research, is based on existing theories and tries to contribute to the research that has already been done. Therefore, my coding will be based on theory, rather than from the empirical data as such (Eriksson & Kovalainen, 2008).

Afterward, my strategy for analyzing the data is grounding the data in the theoretical framework. Since this is a qualitative study, I will be mainly analyzing words instead of numbers (Seale, et al., 2004). I will use analytic techniques that can be used in business-related case study research, such as content analysis, critical incident analysis, and conversation analysis (Eriksson & Kovalainen, 2008). I am planning on exploring the data by examining the coded transcripts, and search for small segments as well as larger entities (Seale, et al., 2004). I will analyze how the data compares to the theoretical framework and where it might differ from it.

I will structure this case study in thematic order and use pattern matching as a technique. It revolves around finding patterns from empirical data and comparing them with the suggestions pre-developed based on existing theory. This means I will first go through the number of different challenges that I derived from the literature. Then I will analyze which challenges were present in the empirical data that were not mentioned in the literature. Then I will go through the strategies that were derived from the literature and match them with the data. Afterward, I will analyze which strategies came up in the empirical data that were not present in the literature. I am convinced that by conducting my research in this way I will be able to construct meaning in my research and achieve a holistic structure (Eriksson & Kovalainen, 2008)

4 FINDINGS

In this part of the thesis, I present the findings that I made. The chapter largely follows the structure of the interviews as it is defined in the interview guide (See Appendix 1). For each subsection, I will first present the findings from CargoBeamer and then the findings from Nikrasa.

4.1 Business model

In this part, I lay out the business models of both companies.

4.1.1 CargoBeamer

CargoBeamer has the approach to be completely integrated vertically. The CEO explained that they take on the majority of the value chain in combined transportation. They are technology providers, terminal owners, and operators, wagon renters but also marketer and operator in the combined traffic cargo sector. That is not that common in the industry. Typically, the classical operator uses third-party terminals, rent wagons or rolling stock units and only takes on a little bit of the market risk. They integrate all of this. That is what separates them in the business model from other companies. Their wagons are more expensive than the classical double pocket trailer and therefore more expensive to rent per day. But because of their marketer experience and their position as a good operator, they are able to tackle the market of the non-cranable trailer and generate higher profit. They are able to ask for higher prices from customers. CargoBeamer also works with terminals from third parties. The mechanical engineer pointed out that the carriages are constructed in a way that they are able to use all container terminals in Europe that use normal types of gripping pliers, all terminals that handle swap bodies or modified semitrailers. The terminals take the transport tub out of the wagon and can extract the trailer out of the tub. The director of business development mentioned that as an operator they offer their own routes, but they also build their own terminals. They are also wagon holders, they have their own wagons and rent them to other subsidiary, the intermodal operator, which offers routes. At the moment, the company serves their main route of Kaldenkirchen, which is near Venlo, at the Dutch border, and Domodossola, Northern Italy. They run three trains per day, which amounts to 70-80 trucks per day. All in all, they have transported 70000 trucks. They also have additional routes to Lithuania, which were added very recently. Currently, they run six trains per week there. They are having test runs to Perpignan, France, at the moment. They have 300 wagons and ordered 216 additional wagons.

The CEO said that the "standard technologies in transport, which can be transported by crane and then on trains, are container, swap bodies, and modified semitrailers. CB has developed a technology that is able to transport all types of trailers independently from their construction type. "

The CEO said that the company works together with other train transportation companies, which are companies that carry trains with locomotives, for example, the Swiss Bern-Lötschberg-Simplon-Bahn but also Deutsche Bahn Cargo. They share projects such as accessing the technical conditions of a new route and optimizing parameters. They also work together with terminals as third-party operators because they share common interests such as having fully loaded trains to increase the attractiveness of the location. They work with third operators that load and unload their trains and they work with shippers on the customer side.

The CEO mentioned that before bringing the wagons into operation, they must have been approved by the European and National Train Bureaus, and the routes must be registered at the network infrastructure operators.

The employee of controlling says that CargoBeamer is cost-based. Costs have to be reimbursed per route in relation to the project. They have different segments that need to be addressed. First, they are the owner of the wagons, and have to ensure their maintenance and insure them. Second, they have the terminal area, they have to maintain it and rent it. Third, they have intermodal operations which is the entity that is in contact with customers and sells the services. They are marketing the routes. The intermodal operations generate outside revenues. They sell the routes and gatherers a price per journey. The forwarders book the journey. They go and collect offers from EVUs since they need to buy a locomotive that carries their wagons from the terminal a to b. That is the biggest cost block and makes up 70% of their costs. Other factors are the wagons. They are being paid internally through CargoBeamer stock. They also need to pay the rent for the wagons. The rest costs are terminals as well as parking and lifting operations. The different terminals charge different prices. At one terminal the company only pays for one lifting process. At another terminal, they pay for the lifting process but also that the train is allowed to enter and exit the terminal. There are also differences in charging lifting processes for CargoBeamer or for double pocket trailers for the container. The company believes this is because they represent new technology and there are questions if they can do the lifting process as fast as they claim.

The employee from controlling mentioned that "there are also differences in charging lifting processes for CargoBeamer or for double pocket trailers for the container. Right now, I believe that they are cautious because this is a new technology. And they are unsure if we can do the lifting process as fast as we say. In reality, we see that it does not take longer to lift a CargoBeamer wagon."

The employee of controlling said that they take all these factors into account, and they are able to build the entire cost block. Then they look at what they believe they can drive the train with what occupancy rate. Then they look at what prices are necessary to achieve a certain goal margin. They control if their price finding works. They are following a simple approach, which means they just do cost-covering plus a certain margin. They aim to have a sales margin of 12.5% when they are offering new routes. Personal and administration need to be paid from that.

The CEO and the director of business development explained that the company acknowledges that their prices must be competitive to road prices. The shippers, which are their customers, always compare their prices with the competition. The road prices are at 50, 60, or 70 cents in Eastern Europe and up to 1,20 € in Western Europe. Based on that, the company set their prices in a way that traveling by train is not more expensive than driving on the road. The costs are set so that they include the holding of the wagons, the costs for the rail transportation company (EVU), which carry the trains, the costs for unloading at the terminals, and the own costs, administrative costs. The aim is for revenue to exceed the costs, which is currently the case at the first route when the trains are at full capacity.

The CEO pointed out "I am starting with prices. The prices have to be competitive to road prices. (…) The shippers, our customers, always compare our prices with the competition. That is like in passenger traffic, where if traveling by train is more expensive, I will only do it if the advantages are better, otherwise, I will take the car. The road prices are at 50, 60 or 70 cents in Eastern Europe and up to 1,20 € in Western Europe. Our prices are set in a way that traveling by train is not more expensive than driving on the road and the shipper has still a lot of advantages."

4.1.2 Nikrasa

Nikrasa is part of the logistic competence centrum. In total there are 16 companies and 40 employees. According to the CEO, they are doing all sorts of logistics like combined traffic and switching from road to rail, electronic mobility, building factories, emergency

service, hospitals, all of it. They have also build a magnetic levitation train and they are currently building a big factory for Tesla. They are located in Bavaria on the Chiemsee. The CEO also stressed that they are not a consulting company but want to solve problems for customers. In the field of combined traffic, they are developing our own things such as software. They work closely with the state of Bavaria and present their concepts to the Bavarian minister. Some of their projects are publicly funded with up to 50% coming from the state of Bavaria.

> *The CEO explained "We are a neutral company. We are here to solve problems. We are eligible for high jobs. I was allowed to present our concepts to the Bavarian minister. If we develop something like the future trailer, we invite the six biggest trailer manufacturers, and they show up. It is a publicly funded project to 50% from the state of Bavaria. The rest is paid by the industry and the results are public."*

4.2 Technology

In this part, I present the findings of the technology of both companies.

4.2.1 CargoBeamer

The CEO mentioned that CargoBeamer has developed a technology that is able to transport all types of trailers independently from their construction type. They can transport classical trailers, cooling trailers, liquid trailers, and mega trailers but no dangerous goods. The mechanical engineer mentioned that the wagons are authorized to be moved in Europe but are not authorized for use in Russia or China at this point. Furthermore, he explained that there are two approaches being used in the field. These are horizontal loading and vertical loading. In horizontal loading, there is only one offer in the market which is the Modelor technology. In vertical loading CargoBeamer wagons are being compared to Iso wagons and Nikrasa wagons. Three Interviewees said that the big difference to those technologies is that CargoBeamer combines both and they are the only ones who do that. Therefore, they have the big frequency advantages and efficiency advantages of the horizontal loading with their own terminals, but they also have scale and growth opportunities, which Modelor does not have. That is because they use third-party terminals and are not bound to their own terminal locations. Another advantage is that they can work automated, meaning their process is possible without manual labor. Interviewees claim that this means it is more cost-efficient and faster. The director of business development explained that other operators such as Modelor need two people per wagon to operate. They also do not have any time advantages in regard to the vertical

process and they are bound to their own terminal modules. They cannot use third-party terminals. They can only transport cranable units. Another advantage is that the CargoBeamer tub can transport deeper trailer like the cooling trailer because the new generation has a sunken tire space.

> *The director of business development mentioned "If we look at this field of technologies, you could say that a big difference is that we combine both. Nobody else can do that. We have the big advantage that we have frequency advantages and efficiency advantages of the horizontal loading with our own terminals but also that we have scale and growth opportunities, which Modelor does not have. That is because we use third-party terminals and are not bound to our own terminal locations."*

The mechanical engineer stressed that there is always potential to improve the technology. But the wagons that they have been using since 2011, will only undergo small changes. Bigger changes must also be registered and checked. Therefore, the plan is that over the next couple of years, they will let the wagons stay as they are right now. Interviewees have mentioned that they have proven their worth because they are very robust.

In terms of aerodynamic, the engineer mentioned that in cargo transportation it is not necessary to include those aspects. But they must be careful with the trailers since there have been accidents in the past for example in Denmark. Under certain wind conditions, it can become dangerous if the trailers are too light. Then the authorities might determine to stop all trains. In general, aerodynamics makes up about 10 % of the resistance of the train, and they cannot change the construction form of the trailer. The reason is that they cannot change the required distances between wagons and speeds and profiles. They feel that they are being restricted in this regard. The CEO explained that they try to build the wagons short, to have a high number per train. Opposite to that is the length of the trailer. He mentioned that it is good that they are standardized. The company thought about encasing the entire train but concluded that it would be a cost issue. However, two interviewees point out that rail requires only one-quarter of the energy than the road. They say that they are very energy efficient already and the rail is the most energy-efficient method of transportation along with ships in regard to the net total.

Regarding extreme weather situations, the mechanical engineer said that the technology is very resistant, but the crane terminal must stop operating when the wind reaches speed 5 or 6 on the scale. CargoBeamer, however, does not have to stop. The wagons are very robust, the terminals do not have cranes. They work with technology that is embedded into the ground. Only in the case when the ice is more than 5 cm, then they would have to stop with their operations. They stress that at that point all the cranes have stopped, and the customers are not getting into the terminal. In case of so much ice, nobody is driving on the street anymore. Interviewees mention that so far, they have not had to stop their operation because of natural events, which amounts to zero times in five years. Of course, should the rail track be stopped because of snow then their train would stop as well. But that would not be caused by their technology.

The mechanical engineer mentioned that "the terminal in Wolfsburg has experienced winter conditions and had no problems. The technology was so robust that it works even under ice conditions."

Regarding accidents, the CEO pointed out that they have moved 700 million t/km and have had zero accidents. Since there are accidents on the road, they conclude they are safer than the road up to this point.

4.2.2 Nikrasa

Nikrasa is designed in a way that doesn't require huge technology to move trailers. The CEO explained it in a way that it works by just laying a plate under the container and then they are able to do everything that they want. This ensures access to combined traffic. The CEO also claimed that they have already solved some issues such as developing a trailer that can be transported on the rail. They also solved things such as moving the lights and the tarp. This could have been a problem since the driver must fixate a belt over it. If this is not done probably it could end up in the high line. What they are currently working on is the terminal of the future. They want to do more with that and focus on things such as service and maintenance.

The CEO stressed that "If you look at our video, you can see that we do not need such a huge technology to move trailers. We just lay a plate under the container and then we can do everything we want. That ensures access to combined traffic."

4.3 Plans for future

In this part, I present the findings regarding what the two companies are planning to do in the future.

4.3.1 CargoBeamer

The CEO said that CargoBeamer plans to be operating their own terminals and they expect that to happen in about 12 years. All together their plan is to have up to 20 own terminals, up to 40 own routes, up to 8000 own wagons, and a turnover of over one billion euro. In more short-term plans, the director of business development mentioned that they are working on something called the Core Network Europe plan. The financing for this plan is already secured. That revolves around having their own three terminals. That network includes the first three terminals, which are in Calais, Germany, and Northern Italy. CargoBeamer has ordered 216 new wagons; they will arrive in 2021. Till the end of next year, they want to go from three trains per day to 12 trains per day. They will operate the routes Calais-Domodossola, Calais-Kaldenkirchen, Calais and Southern France.

> *The director of business development stated "Our plans are ambitious. The short-term plans are called the core network Europe plan. That revolves around our three own terminals. That is a network around the first three terminals, which are in Calais, Germany, and Northern Italy."*

But the director of business development said that they also want to evolve their main route further because they see potential in the route between Kaldenkirchen-Domodossola. Interviewees also stressed that the company wants to continue its efforts regarding Lithuania. They were the first non-cranable units that drove to the Baltic states. The Kaunas terminal is connected to the European railway and they want to have two or three trains there per week on that route. Afterward, there are plans to look at routes to Scandinavia. The company would like to transport fish from Norway through Sweden, and then through Europe. Also, they would like to look at Southern Europe and transport fresh fruits from there. They also would like to look at Southeast Europe, maybe Romania. Interviewees pointed out that the land way to Turkey could also be interesting. And then of course new targets in Italy more to the east like Verona. They want to build 23 terminals and I have 6000 rolling units until 2031 in Europe.

The CEO and the director of business development both believe that their technology could also be interesting for markets outside of Europe. The entire Russian market could be interesting for their technology. Then they work on other innovations, other container formats that are optimized for the railway. Sea containers are of course optimized for the ships. They work on that and also want to tackle the Chinese market with that and

participate with the new silk road that is being built. Both interviewees clarified that this is more middle to long-term planning. They are working on the permits for the Chinese markets. Their best guess is that this would take 5 to 10 years.

> *The director of business development elaborated "I believe our technology could be interesting for markets outside of Europe. The entire Russian market is interesting for us and our classic CB technology. Then we work on other innovations, other container formats that are optimized for the railway. Sea containers are of course optimized for the ships. We work on that and want to tackle the Chinese market with that and participate in the new silk road that is being built. But that is more middle to long term."*

In terms of numbers, the employee of controlling explained that they are looking at turnover, transport volume, compared to the sum of cargo transport in Europe on routes that over 400 km long. The company plans on having 4% of the market share. That would be 2 billion in turnover in 2032. They look at the cost side, which is the costs of shunting per revenue. They want this number at around 50 – 60% of EBITDA per sales.

4.3.2 Nikrasa

The CEO said that they could still reduce the weight of the trailers, which means that there will be less steel to be driven around. They also work on a project that is called Hamburg Bavaria 62+. This aims to increase the percentage of container transports from 62% to 72%. They also want to help fix the technological side of rail transportation, so that there will be an increase in the transport volume in rail. The CEO believes that they could increase the modal split by 2% every year. They are also thinking about building more terminals but that takes 15 years. The CEO also believes that they could improve the software and design the terminals in a more intelligent way.

> *The CEO pointed out" If we look at the alps, we have 28% for rail right now and 72% for the road. In Switzerland, it is exactly the opposite. 72% rail and 28% road. If we fix the technological side, I think we could increase the modal split by 2% every year. That would be realistic. The limiting factor is not the wagons or trailers but the terminals."*

4.4 Advantages

In this part, I present the findings on what the interviewees consider their biggest advantages.

4.4.1 CargoBeamer

Three interviewees believe that their main advantage is that everybody can use their technology. They believe that they are looking at a huge market. The biggest part of the freight transport market is the non-cranable units. They say that it is the part that has the biggest growth and the least amount of competition. The CEO explained that the situation in the combined train transport is that only 10 percent of trailers can be transported and only 5 or 7 percent of all trucks. 75 % of all transport in Europe is done by using trailers, over 1000 billion t/km per year. The entire combined transport in Germany has only 40 billion t/km, which means 960 t/km could still be switched onto trains. Therefore, they see massive growth potential there. Because the business model is so that all types of trailers can be transported, the customer won`t have to do anything.

> *The CEO said "everybody can use it. If you compare it to trains, you can imagine that if for example, only people can get on board if they are between 15 and 20 years old or male or 1,70 meters tall. You would say that only 10 percent of all people can travel by train, then the business model would not be viable. That is the situation right now in the combined train transport."*

The second advantage that two interviewees see is that the terminals are automated and have a high throughput. The money saved from this can be used to invest in the terminal. Automatic loading results in more precise loading and fewer damages. It is also possible to pre-prepare the trains. In combined traffic, the goods have to get from point A to B as quickly as possible. The situation currently looks like that they are often standing around at the terminal for 6 or 7 hours with train and locomotive, which are expensive, and there is no way to earn money. The CEO stressed that this is not economically viable, and it is only possible because countries are supporting them financially. They believe that combined traffic can not grow in this way. They say that they have a terminal with high throughput, the first one in Calais, the second smaller one in Wolfsburg, and they are going to test it throughout the next three years. The first full terminal will be able to transport up to 1000 trailers per day, every train will be unloaded and reloaded within 20 minutes. Interviewees conclude that speed is the second big advantage and that it is going to be the reason to make their business profitable.

The third advantage, the director of business development believes, is that there are multiple megatrends on their side. They say that they are a climate-friendly approach. Rail has capacities, the road does not. Autobahns are full and more autobahns cannot be built short term. Shifting more traffic on road is not desired. Something that has been accelerated because of the pandemic is that we operate without much personnel expenses and far less than on road. Their model with its own high frequency terminals would be able to almost triple the capacities compared to the classic combined traffic. They can drive 12 trains per day in and out of the terminal. They believe that if they can achieve high frequency, which should be possible with their terminals, in an interesting corridor where there are high volumes, then they are attractive for customers. They also think that their potential field of customers is huge. They can work with forwarders, fair providers for maritime connections, but they claim that they could also work with Volkswagen as an end customer. On the political side, there is more and more pressure regarding the cost advantage of the road. Interviewees think that this cost advantage from the road to rail will not be getting bigger but smaller. They can achieve cheaper unit costs through high frequency, cheaper transaction costs, and they believe that they will be the better alternative regarding costs.

> *The director of business development pointed out "but one has to ask themselves why the rail has not worked so far when the market is that big. Why is the road so dominant? That is because the logistic has to be fast it has to be inexpensive. It also has to be fast and reliable. That is not possible right now. Our model with our own high-frequency terminals would be able to almost triple the capacities compared to the classic combined traffic."*

4.4.2 Nikrasa

The CEO explained that Modelor was the first company that brought the technology into the wagon. He said that they were very fast, but they also drove 6 or 8 tons of steel through the landscape. With Nikrasa, he thinks that the big advantage is that everybody can use it and it is much lighter. It doesn't need training to use it. There are no changes at the terminal. Furthermore, traffic flows can change and when someone has already built a terminal they cannot react anymore. They are also planning on introducing a terminal system where they will not need a terminal platform anymore and can just put the plates anywhere.

The CEO pointed out "and what is also extremely important is, and nobody believed me before the pandemic, the traffic flows are not stable for all eternity. They can change and then you have built a terminal that cost 30 million and something happens, and you cannot react. With Nikrasa you can just drive somewhere else."

4.5 Disadvantages

In this part, I present the findings of the disadvantages.

4.5.1 CargoBeamer

The CEO said that he sees multiple disadvantages that impact their ability to grow the company. One disadvantage is the fact that they are a private company. Another disadvantage is that Europe is structured according to state railways. The situation at hand is that most EVUs that are operating in cargo transportation are state-owned railways like DB Cargo or SNCF or Rail Italia, Rail Cargo Austria. He pointed out that currently trains with a state background often are the beneficiaries of state substitutions. Another disadvantage that was pointed out by him is that the market is not liberalized yet. The EU has set itself this goal but so far it has not been reached. Even though there is a train regulation law EREGG, which regulates access to infrastructure, that forbids cross-subsidizing segments of state-owned train companies through income from network means, this practice is still done in Europe. Therefore, this restricts growth. State-owned train companies have other opportunities since they get debt relief worth billions and get equity injected by the state. Interviewees stress that this is something that private companies do not get and represents a fundamental distortion of competition. In his opinion, it represents the biggest cause of halting growth in train traffic.

The CEO pointed out that "a free liberalized access, which still exists in part and which the EU aims for, is not a reality yet. That is why state train companies have other opportunities since they get debt relief worth billions and get equity injected by the state. That is something that private companies do not get and is a fundamental distortion of competition."

Another big disadvantage is the costs. The employee of controlling mentioned that the topic of sustainability is something everybody talks about it, but nobody wants to pay a higher price for it. He said that they have to be competitive regarding road and this cost pressure makes it difficult for them. The lover volumes caused by the pandemic and

lower diesel prices are not helpful in this regard. There is also the problem with dumping prices on several routes such as in Eastern Europe. Two Interviewees conclude that road costs are pretty much unbeatable there and that it is unlikely going to change. Therefore, they must find the right routes where the rail is competitive. On these routes, they can scale up and use the advantage of lower transaction costs. In the future, when they will have a larger network, they will be able to offer more possibilities for customers and be able to charge higher prices.

On the technological side, the engineer mentioned that it is a disadvantage that CargoBeamer is restricted by the length of the trains. Another possible disadvantage he said, is that the company operates a unique system with terminals, which are unique. Therefore, repairs need to be made immediately. Although the technology in the wagons is simple, the technology that is used in the terminals is quite complicated, which can bring up issues if something is not working.

> *The mechanical engineer said "There are disadvantages in every system. We are restricted by the length of the trains. And the terminals are unique. It is one system. It is a special system with its own philosophy just as other systems like Modelor. If something fails it needs to be repaired immediately. It is an advantage that the technique in the wagons is easy, but the more complicated technique is in the terminals."*

4.5.2 Nikrasa

The CEO explained that a big disadvantage is that they still need to solve the market access for 80% of middle-sized companies because they are having problems moving onto the rail. He explained that the reason is that if they send a truck in the evening and there is no equivalent to drive back then it costs money. Therefore, the companies need more units. Middle-sized companies also need to sign guarantees and have other types of insurance. To solve this problem, they are working on something called KMU. The companies can go online and see if there is empty space on a train. He said that DB already has something like this.

Another disadvantage that he sees is that there are different electricity systems in Europe and the systems are so complex that if someone releases an update the locomotive stands for a week. Also, there are problems because programmers work in their own language. This can result in nobody knowing what they have programmed. Another disadvantage is that the rail industry employs technologies that are anachronistic. There are still screw

couplings and that cannot couple automatically. Furthermore, there are a lot of laws and regulations that they have to adhere to.

> *The CEO stressed " there are a lot of national laws. In Italy, there still need to be two locomotive drivers on the train. One must drive and one must brake, which still exists today. Then all of the different electricity systems exist. Nevertheless, I am convinced that we could improve the volume by 20% if we coordinate everything a bit more."*

4.6 Competition

In this part, I present the findings of the competition that the companies are faced with.

4.6.1 CargoBeamer

There are several different kinds of competition that were mentioned by interviewees. The CEO said that one competitor is the state train companies. The state companies do not have a system for combined transport. State trains are the EVUs that carry the trains, but interviewees say that they see that in France they have a system that gets a lot of state money, a system called Lore, which is run by the SNCF, which operates and moves trailers. However, the CEO and the director of business development are adamant that they don`t see it as competition, even though it is said by third parties that it is their competition. The CEO said that it is not their competition because it does not serve the market properly. The French system serves one or two routes and one or two or three trains per day.

Another possible competition is classic cargo transport. The CEO mentioned that there are calls for compulsory regulation in Europe to have only trailers in the classical cargo traffic and change others into classic trailers. Interviewees do not see that as real competition. He mentioned that those calls are 20 or 30 years old and come up from time to time. He said that there are 120 000 semi-trailers being built each year, and 110 000 of those build in different variations such as silo truck, freezer truck, mega trailer, tarp trailer, bulk floor trailer, and other types of special trailer. He believes that the market will not accept being told to standardize because there are half a million or one million trailers in different designs.

The CEO also said that there is competition from companies similar to CargoBeamer. In Austria and Germany, there are attempts to have special loading platforms, ISO in Austria, which was started in 2006, Nikrasa in Germany, which was started in 2012,

there is also Vega. Interviewees say that these attempts never prevail on a larger scale because the loading time is too long. Therefore, they are not generating profit because times are not competitive. The CEO and the director of business development don`t see them as competition because they are not fully automated and don`t scratch the surface of the market with the volume that they can move.

> *The CEO explained "I am back at the example of passenger traffic. If every passenger is separately being put into one train every 5 minutes and as a result, the train is standing at the station for 5 hours, then nobody is traveling by train. On the one hand, it is not generating profit, on the other hand, the times are not competitive."*

Since other competitors were dismissed because they were serving different market segments, three interviewees identified the road as their main competition and the costs that are being paid there. The company compares themselves to the road transport. They want to convince forwarders to switch to the road. Their business model is aimed to open the door by convincing them that every type of trailer can be transported. Regarding transport on the road, the employee from controlling pointed out that they need to offer a product in a price-sensitive market that is a little cheaper. Apart from the pricing, another competition factor is the location of the terminals. This then determines the kind of competition that the company is faced with.

4.6.2 Nikrasa

The CEO believes that in combined traffic, everything is great, which helps to switch to rail. He hopes that Modelor and CargoBeamer systems can all stay. However, he stressed that in his opinion the person who supported CargoBeamer did not ask the market but asked the engineers. He believes that if someone looks at pictures they will see that CB is technologically perfect but economically difficult. But he admits that they sell themselves well. The CEO points out that if one looks at the two technologies side by side they see that Nikrasa is filigree and weighs 2 tones and CB is about 9 tones. If one calculates that, it means that if 30 wagons are moved over the alps that will be an additional 300 tons of steel.

4.7 Obstacles

In this part, I present the obstacles that the companies need to overcome.

4.7.1 CargoBeamer

Interviewees pointed out multiple obstacles that they will need to overcome to grow their business. The CEO said that one obstacle is the missing liberalization of the rail cargo market in Europe. This has been stated as a clear goal of the EU guidelines but has yet to be achieved.

Other obstacles revolve around financial restrictions that impact the number of investments, the strength of the terminal network, and the number of wagons. The CEO stressed that one wagon costs 120 000 to 140 000 euros and a combi terminal, crane terminal or their own terminal costs between 20 and 40 million euros. Those are huge investments and the duration and planning take up 5 to 10 years. The terminals need to establish themselves and infrastructure projects take longer than simple rail projects. If more terminals are running it will create a better flow. This will create a network effect where forwarders will not be able to pass this. Since not all terminals can be built at the same time, the timeframe to build a combined network is decades.

> *The CEO stressed that "these are huge investments, and the duration and planning are faster than the Berlin Airport, but you still need to calculate with 5 to 10 years. And 5 to 10 years are 5 to 10 years and considering that I can`t build 120 terminals at the same time then we talk about decades here."*

Another big obstacle is to secure the locations. The director of business development said that it is important for the company to find the right locations where they can establish themselves. One interviewee mentioned that they have now selected, what they believe are the right terminals 4, 5, and 6. In order to finance these long-term plans, it is therefore paramount to have the right kind of shareholders, who support this strategy.

Another continuous obstacle is in the form of the EVUs. The company needs to work with them to be able to drive the trains like they want to. Therefore, there is always the issue of having EVUs that are on time and are high quality.

Finally, the COVID-19 pandemic also presented an obstacle to the company. The employee from the controlling division said that despite the fact that their market share and volume were almost the same, the price level dropped. There were a lot of empty drives from the forwarders. The price level presented a small deficit, although this has lessened as 2020 went on. The transport volume was still high. He concluded by saying

that the company would have been more affected by the pandemic if they had a big network because then they would have been more sensitive to the economy.

4.7.2 Nikrasa

The CEO stressed that one obstacle is the issues surrounding the shipper. He explained that they have pressure if the CO2 is priced in. Furthermore, there is political pressure because the road infrastructure is not expendable. He mentioned that there are challenges with the forwarders. Also, there are public protests from people who are saying that the trains are too loud. The CEO pointed out that they have 12 demands for politics. This includes that politics should not get involved in things that the industry can solve through technology. There are also problems with regulation. Another obstacle is that if one drives from Verona to Munich, it only requires one driver. But on the rail, there is more to coordinate, and much more complex. The CEO also points out that the subsidies currently mainly make up the disadvantage that there are faced with but don't yet encourage switching.

> *The CEO mentioned that "We had a call with the transport ministry, and we talked about effective transshipment facility. The regulation says that the top consists of concrete. If one innovative company says we do that with asphalt or hard plastic it would be much lighter, much more resilient. In Germany, this is not supported because it is not concrete."*

4.8 Strategies

In this part, I present the strategies that the companies use to tackle challenges and address inhibitors.

4.8.1 CargoBeamer

The company uses different strategies when tackling challenges and addressing problems. According to the CEO, they always work one or two years on every respective route to check out all difficulties. This means that they drive trains on new routes such as to Lithuania through Poland, or to Perpignan through all of France. They are testing with pilot trains and simulate all real customers in order to detect all difficulties. Their strategy is to test piece by piece and reduce all problems in coordination with partners.

Working with strong partners is also an important strategy. By having close cooperation with local partners, the company doesn`t have to do everything by themselves, which saves them time and resources. The CEO said that they work with EVUs, terminal

partners, local politics, the local population, and try to include them as well. They also work a lot with the authorities to get approvals. For example, they included them proactively in 2004 to get approval for their wagon. The interviewee stressed that the process is fairly complicated with rail and nothing is happening without the permit authorities. Therefore, they always have to update them if they are building a new type of vehicle. However, the director of business development mentioned that they do a lot not with help from politics but despite politics. He said that they want to achieve success with their own means and money. They aim to build the first part of the network and show the benefits of their technology in real life. By showing their ideas in reality and establishing the network and the first terminals they believe that they can make a structural difference and convince people that are still skeptical.

> *The CEO said that "strong partners are important. Local partners are important, so we do not have to everything by ourselves. We work with EVUs, we work with terminal partners. We work with local politics, with the local population, and try to include them as well. We work a lot with the authorities to get the wagon approval. We included them proactively in 2004. Working with partners is most important."*

The CEO said that another important strategy is to have strong patent protection. In the past, there were companies who tried to copy their technology back in 2005. Therefore, patent protection is extremely important to ensure legal protection for their technology.

The employee from controlling explained that when planning for the existing routes, they use specific parameters. In that case, the market side meets with the financial side and they come up with a plan that is used for forecasting. If there is disagreement, this needs to be resolved on a level higher up.

The director of business development mentioned that when strategic decisions need to be made, the executive board and the supervisory board come together. He explained that the company is proactive with that and the executive board is always ready and on hands when it comes to the operative business. There are three members on the executive board and six members on the supervisory board. They discuss strategic decisions in the executive board first and then with the supervisory board. This should ensure that they bundle knowledge and acquire a full understanding of the market. He emphasized that it is extremely important to understand out of which reason a customer is putting a trailer onto the rail and most importantly why not. Furthermore, strategic decisions

require full knowledge of rail transportation, technical knowledge, and political knowledge. By involving multiple members, the company aims to gather all knowledge and possess sufficient information to make the best decision possible. If there is additional knowledge needed, the company tries to get specialists that have been involved in the project for a long time. Additionally, they hire consultants or involve the German regulator TÜV when it comes to matters related to the vehicles.

> *The CEO mentioned, "it is very important to understand why customers use our product and even more importantly why they do not."*

A strategy that was emphasized during the COVID-19 pandemic, according to the director of business development, was to communicate and use their advantage that their product is interesting for everybody. They are able to drive for customers that operate in all kinds of industries. Therefore, they were driving a variety of different things. They can drive on all routes with all trailers. He mentioned that they were able to communicate to their customers that they still had advantages and would continue to drive their trains since there are no border controls. By communicating effectively and being flexible in what to transport, they were able to run trains at full capacity during the entire pandemic.

> *The director of business development explained "we saw that we had a massive advantage due to the fact that our product is interesting for everybody. We drive for customers that operate in all kinds of industries. We do food, flowers, toilet paper. We can drive on all routes with all trailers. That is why the pandemic has not affected us too much."*

4.8.2 Nikrasa

The CEO explained that if they are faced with a challenge, they introduce a big project. He said that they do classical project management with a high amount of subject knowledge. He stresses that they believe they need to be 50% better than their customers in their knowledge about details. When talking to 6 trailer manufacturers they really need to know everything, so they don't leave. When they are in their project, they do not have to pay attention to compliance because they are then allowed to share information. The CEO stressed that if they are able to build railable trailers they can increase their market share by about 30%. If then shareholders see the number 30, that would open all doors for them. But he also stressed that change management is not an easy thing to do.

4.9 External support

In this part, I present the findings of what kind of external support the companies receive.

4.9.1 CargoBeamer

According to the interviewees, CargoBeamer receives support from multiple different entities that are either economical support or political support. The director of business development said that regarding economical support, the EU has supported a pilot project in 2009, which was a development project. In Calais, they get support for the terminal in Calais. They get support for the development of terminals in other countries as well. One part is from the EU program Connecting Europe. Other are national federal programs. In Germany, they get support from the Ministry of Transportation of Germany, which supports terminals in Germany by up to 75%.

They get support from the Ministry of Transportation in Switzerland for terminals in Italy. They also get support from the Swiss Ministry of Transportation for trains that drive through Switzerland. They get support for every shipment that is transferred from road onto the rail. Switzerland also supports strategically important projects with other types of support programs. They also get a noise bonus in Switzerland, which is the only country that offers that. Multiple Interviewees stressed that Switzerland in particular is doing a lot for them and they consider them role models in Europe. Apart from that, there are also support programs from private companies. In France, there is money for anyone that has a sustainable solution regarding logistics. In Austria, they get a bonus per shipment.

> *The director of business development stated "We get operational support on several tracks in different countries. For example, that is the case in Switzerland. You get support for every shipment that is transferred from road onto the rail. Switzerland also supports strategically important projects with other types of support programs. Then there are support programs from private companies."*

In terms of political support, interviewees disagreed about the level of support that they feel is there for CargoBeamer. The CEO thinks that the EU support for terminals is very good. Furthermore, they pointed out that the Federal support of the German Government is very good because they get up to 80% of terminals in Germany supported

by Berlin. They also receive support through the members of the German parliament and one interviewee feels that there is strong support for them. However, the director of business development felt that there is selective support. The interviewee agreed that there is individual support from people from politics that understand and support them. The interviewee mentioned the mayor of Calais, who supported them not only financially but also with effort. This sped up the process of building a terminal, which was the reason that their first terminal was built in Calais. In Germany, there are mayors in certain regions that support them. But the interviewee mentioned that they felt that the Transport ministry is more supportive of the car industry. Because of this, there is no real big push for their technology.

> *The CEO thinks that "of course they work on this on a European level to work more spontaneously. But the political efforts for a framework for train operators are fundamentally important to switch traffic. If this is not done there will not be a switch and we will still drive on the road with trucks 20 years from now."*

The CEO said that in Switzerland, the Federal Office of Transport (BAV) supports infrastructure facilities including CargoBeamer if trains drive through Switzerland. Additionally, there is operator support in Switzerland per shipment, which is granted to every operator in what interviewees mentioned, is a really fair process.

4.9.2 Nikrasa

The CEO mentioned that they receive support from Pat Cox, who is the former president of the European parliament. Then they receive support from EU coordinators that for example coordinate the tunnel in Bremen. He stresses that politics is important since if the electrical systems are not synchronized the industry cannot do anything about that. He also mentions that there are standards for back light that need to be set. He believes that politics needs to invest in infrastructure and move its focus away from road investments.

> *The CEO explained "It really is politic. If the electrical systems are not synchronized the industry can't do anything about that. Also, the locomotives have to log themselves into a new system when driving through Europe. That's like if you shut down your Windows computer and restart them. These are the topics that politics need to address."*

4.10 Hopes for the future

In this part, I present the findings regarding the hopes for the future from the two companies.

4.10.1 CargoBeamer

Interviewees mentioned several things that they hope will be established in the future and that would help their technology to grow. One very important factor, according to the CEO, is effective enforcement of the existing train regulation law, discrimination-free access to rail infrastructure, and especially a ban on cross financing of state companies through revenues out of network operations. He mentioned that despite this being an existing law, there is still mixed financing, which is a grey area. Discrimination-free access in Europe is very important for everybody not just for CargoBeamer. Also important are laws that regulate traffic conditions on the road. The director of business development analyzed that the train packets from the EU are good in theory but difficult to apply in real life. There is also a huge imbalance of requirements of locomotive drivers and truck drivers. It would be helpful to have things like the toll on Autobahn or more support for shipments that are transferred onto rail. The employee from controlling stressed that the road needs to be forced to operate in a realistic cost structure. That means toll, that means CO2 taxes and participation on external effects. If there is a realistic cost picture, then the comparison for rail would be much better. Additional issues such as exploitation of drivers must also be addressed.

> *The employee from controlling said "I think that the environmental aspects will be back in the spotlight soon. When the corona crisis is done then we will get more support. But I think it goes in the right direction politicly. They have been doing the first steps, right now it is not enough but it will come, I believe. "*

The director of business development believes that legislation with a focus on the environment would help. This could take the shape of putting prices on CO2 or establish emission trading. Higher CO2 prices in Europe would help rail. In general, interviewees believe that EU politics is very important for rail since they are not as advanced in Germany. They are much more advanced in Switzerland. He pointed out that Switzerland has a tax on heavy trucks, which helps every company, that operates on the rail.

Political support of combined rail traffic in cargo transportation in a nondiscriminatory fashion is also important. The CEO thinks that Europe should invite tenders for cargo handling. To achieve the climate goals, must at least one-quarter of traffic performance switch onto the rail. A serious traffic policy must enforce that and must pursue this in an active manner. According to EU law, this must be invited to operators, but he said that this is not done in reality. It is only being done on a communal level, which is patchwork. However, a European effort is required to achieve a change of traffic. Interviewees said that the effort of the Trans European Network, to massively extend the corridors Europewide, is enormously important for all other operators on the rail. It is the foundation for moving long cargo trains through Europe quickly.

> *The CEO explained "If you only want to switch 10 % you would need around 100 terminals in Germany. That would require plans for the district, local plans, traffic networks, public engagement efforts, 100 times in Germany and 300 times in Europe. A serious traffic policy must enforce that and must pursue this in an active manner."*

Another important factor is the capacities for reserving routes. Currently, interviewees say that they register routes 15 months in advance to run their trains. But if a road forwarder wants to run a truck, that can drive on short notice. That is a massive time difference that means the flexibility of rail has to be increased. That has been recognized and now work is being done on a European level to enable more spontaneous operations. In Germany, things are being made harder through things like the planning approval procedure. Interviewees pointed out that the entire process needs to be sped up. It cannot be the case that a terminal construction takes four, five, or more years.

The CEO and the director of business development hope that the EU would take a look at what Switzerland is doing and copy several things from them. Even though Switzerland is not a member of the EU; they are strong with support for terminals in other countries. They want that the trucks that drive through Switzerland to drive on the rail instead. Switzerland not only supports terminals but also has operator support. Every electro mobile truck, which is emission-free, gets 5 cents. Interviewees concluded that this is a manageable financial effort to support electro-mobile transport in a nondiscriminatory way. They also said that they are discussing this with German authorities and German politicians.

The director of business development pointed out that it is critical for their operation how many terminals they have. The terminal locations determine the position in the

market. Therefore, they need a strong investor or be listed on the stock market. Something that enables them to build parallel terminals and look for locations and engineer all at the same time. They believe that if they had a big network, their business model would succeed immediately.

Finally, the director of business development is hoping that the environmental aspects will be back in the spotlight soon once the pandemic is over. They hope that customers start demanding that companies like Amazon are doing something for sustainability. Then the forwarders would have pressure to do something, then forwarders have pressure. Right now, interviewees believe that nobody is looking at the supply chain and nobody thinks about how much CO2 emissions were created through transportation. If there is going to be a massive change in the awareness about this in society, then the potential for them, they believe, will be massive.

> *The director of business development stated "Everybody talks about plant-based food. It is a gigantic growth market. The supply chain is not looked at. Nobody thinks about how much CO2 emissions were created through transportation. There is going to be a massive change. As soon as this awareness is there in society, then we have to be there. Then we cannot be just a vision for the future. Then the potential will be massive."*

4.10.2 Nikrasa

The CEO hopes that all companies act responsibly and are aware of their responsibilities. He believes that they are not evil because he says that he knows that they are all motivated, but the structures are not able to solve the problem. People, who work in rail, do things with good intentions and to the best of their abilities but there is no overview from someone above them to set the norms. He believes that is what the EU must do. The CEO also stresses that this must be done fast because they need to create security for the investments.

> *The CEO explains "If someone changes the ETCS and someone bought several locomotives until they are going to be delivered in 5 years, they are worthless. Or we can just take away the rail and instead install a magnetic levitation train (laughs)."*

5 DISCUSSION

The results indicate that there is a great number of challenges and inhibitors that a company that works in the field of intermodal transportation faces. The data suggests that these challenges and inhibitors come from a variety of different sources and include technological, legal, and economical challenges. The results also indicate that the strategies that are being used to counter the challenges are diverse and involve more things than cost calculation and optimization. The study suggests a correlation between the challenges that are encountered, and the strategy applied to overcome them. In the following, I will answer the research questions and lay out the contributions that can be made from this research. I will also state the implications and give further research suggestions. I will first analyze the different challenges, then address the inhibitors, and then go over strategies.

5.1 Biggest challenges to intermodal transportation

In this part, I present the biggest challenges to intermodal transportation.

5.1.1 Operational challenges

Regarding operational challenges that persist in the field of intermodal transportation, the results suggest that one of the big challenges comes from the fact that these are new technologies that are unknown and terminal operators are still skeptical about this. As interviewees have mentioned, there are differences in charging lifting processes for CargoBeamer or for double pocket trailers for the container. The data indicates that this is because it represents a new technology and there are questions if the lifting process is as fast as is claimed. This exists even though, as the mechanical engineer pointed out, the carriages are constructed in a way that they are able to use all container terminals in Europe that use normal types of gripping pliers, all terminals that handle swap bodies or modified semitrailers. The concern of terminal operators is understandable since previous research by (Vis & Carlo, 2010) has pointed out that the volume of cargo is starting to cause logistical concerns. If new technologies cause problems, it would increase the loading times and further contribute to those concerns. The results suggest that these concerns seem to persist even though the company has said that they work together with terminals as third-party operators.

The results suggest that the challenge of container dispatching is not as big. Previous research by (Nossack, et al., 2018) has stated there are two types of trailers. But the CEO of CargoBeamer has mentioned that they have developed a technology that is able to

transport all types of trailers independently from their construction type. This has also been confirmed by data from the CEO of Nikrasa, who stated that they have also developed a technology that can transport different trailers on the rail.

Results indicate that CargoBeamer has the big frequency advantages and efficiency advantages of the horizontal loading with their own terminals, but they also have scale and growth opportunities. That is because they use third-party terminals and are not bound to their own terminal locations. Another advantage is that they can work automated, meaning their process is possible without manual labor. Interviewees claim that this means it is more cost-efficient and faster. The results suggest that this would be a way to combat the challenge mentioned by (Garehgozli, et al., 2015) and (Vis & Carlo, 2010) which both state that it is important that container terminal operators can efficiently manage the logistic operations of the terminals and deal these massive volumes of containers. By using their own terminals, CargoBeamer could take pressure from them and potentially lower their cargo volume. The data indicate, however, that this only applies if intermodal companies use their own terminals. As interviewees have mentioned, this is not the case for every company.

In terms of aerodynamic, the results indicate that aerodynamics makes up about 10 % of the resistance of the train, and it is not possible to change the construction form of the trailer. It is also not possible to encase because of cost issues. There are restrictions due to the length of the trains. The results confirm the findings and build on the existing evidence from (Lai, et al., 2008b), which stated that IM trains are the least fuel-efficient trains because of the physical constraints imposed by load configuration, placement, and railcar design. The results also indicate that intermodal transportation only accounts for one-quarter of the energy than the road. There seems to be no desire to further try to decrease resistance since rail is the most energy-efficient method of transportation along with ships in regard to the net total. While previous research by (Lai, et al., 2008b) focused on maximizing the aerodynamic efficiency of IM freight trains, these results indicate that it is not high on the priority list.

5.1.2 Organizational challenges

The results suggest that a big organizational challenge results from the fact that CargoBeamer has a completely vertically integrated approach. Therefore, the company takes on the majority of the value chain in combined transportation, which is uncommon in the industry. They must accept considerable market risk. These findings are in line

with previous research by (Luo, et al., 2016), which stated that the intermodal industry operates in a highly volatile environment.

The data suggests that the wagons are more expensive than the classical double pocket trailer and therefore more expensive to rent per day. But because of marketer experience and their position as a good operator, the company is able to tackle the market of the non-cranable trailer and generate higher profit. They are able to ask for higher prices from customers. The results confirm the research by (Tawfik & Limbourg, 2019), which mentioned that a company needs a competitive "market-survival" strategy. The results also confirm the assumptions made by (Li & Tayur, 2005), which states that a customer selects a service not just based on the price, but also based on their evaluation of this service.

The results indicate that a massive challenge is the market access for middle-sized companies. These companies are lacking in units to have an efficient operation on rail. These results are in line with the hypothesis of (Ricci & Black, 2005), which identified two major cost drivers in operations as the efficiency of operations and the load factors. It also confirms the hypothesis that one possible strategy to overcome the pricing problems is to increase the load factor. The results also confirm the existence of an empty freight car distribution problem, which has been identified by (Holmberg, et al., 1998).

Another challenge is the EVUs. The company needs to work with them to be able to drive the trains like they want to. The EVUs need to be on time and of high quality. The results are in line with the hypothesis by (Newman & Yano, 2000) that intermodal transportation faces challenges connected to basic management and information limitations, which can cause poor train routes and schedules as well as inadequate priority rules for shipments.

Results suggest that the COVID-19 pandemic is a challenge for the company. The price level dropped, which presented a small deficit. This would have been even bigger if the company was operating with a big network. The results confirm the previous research by (Tawfik & Limbourg, 2019), which states that intermodal transport competitiveness is highly dependent on setting the right service tariffs and this is one of the main weaknesses in the quest to generate economic success.

5.1.3 External challenges

The results indicate that the majority of companies in the intermodal transportation sector including CargoBeamer and Nikrasa follow a vertical approach. Modelor is one company that follows a horizontal approach. They need two people per wagon to operate. They also do not have any time advantages in regard to the vertical process and they are bound to their own terminal modules. This is also partially true for CargoBeamer since they intend to mainly rely on their own terminals in the future. The challenge comes from the fact that systems that rely on their own terminal are closed in themselves and cannot be fixed or repaired by someone else. Therefore, companies that rely on their own terminals need a big degree of self-reliance and competence to keep operations running. These results build on the existing evidence by (Chen & Miller-Hooks, 2012), which states that resilience is dependent on the network structure as well as activities that preserve or restore service in case of a disaster. As the results have shown, companies operating in intermodal transportation can have their own network structure that is maintained by them. Therefore, they need to be able to depend on themselves to fix things in case of a disaster. The results contradict the claims of (Faturechi & Miller-Hooks, 2014), which points out that systems are interdependent, and interconnected. The systems of some intermodal companies are not interdependent or interconnected to other entities. Even though they are closed they nevertheless need to be resilient in the face of disaster. Since (Faturechi & Miller-Hooks, 2014) proposed a resilience indicator to quantify a network`s resilience, it is important to keep in mind that some networks mainly only consist of one company. Therefore, this needs to be considered and suitable amendments might need to be made to the indicator to acknowledge this.

Regarding the challenge of extreme weather situations, the results indicate that the crane terminal must stop operating when the wind reaches certain speeds. But CargoBeamer`s own terminals do not have cranes and therefore do not need to stop. Those terminals only have to stop when there is a lot of ice. The results make it impossible to confirm or contradict the claims by (Chen & Miller-Hooks, 2012) about how post-disaster activities can drastically improve resilience levels and mitigate the negative effect of disasters. There is no data at this point on how recovery activities impact the network's ability to recover.

5.2 Main inhibitors

Apart from the challenges mentioned in the previous part, there are also a number of inhibitors that pose a challenge when trying to increase the usage of intermodal transportation.

5.2.1 Legislation

As (Macharis & Pekin, 2009) have found, it is crucial to have the right kind of policy measures to lend support to intermodal transportation. This hypothesis was supported by the data. Both companies stressed that there are currently problems with regulation. This puts them at a disadvantage to compete with road since on rail there is more to coordinate, and the situation is much more complex. Therefore, the current legislative situation does not encourage switching from road to rail.

The data suggest that one big challenge is that Europe is structured according to state railways and trains with a state background often are the beneficiaries of state substitutions. The results suggest that the train regulation law EREGG, which forbids cross-subsidizing segments of state-owned train companies through income from network means, is not effective and the practice is still done in Europe. The data suggests that this is a big cause of halting growth in train traffic. These findings are in line with the hypothesis by (Kumar & Anbanandam, 2020b), which states that institutional challenges need to be recognised that hamper the development of intermodal transportation. Since the regulation does not seem to have the required teeth to eat, there might be the need to craft a different type of legislation or amend the existing one to achieve the desired outcome.

Another challenge is the different electricity systems in Europe and the use of different programming languages. The data suggest that standardization would be helpful to combat this issue. On the other hand, the data also suggests that there are too many there are a lot of laws and regulations that need to be adhered to. The results suggest that the missing liberalization of the rail cargo market in Europe presents a challenge. The results suggest that it is important to include the liberalizations of the rail cargo market in TRILOG, as stated by (Tsamboulas, et al., 2007), as a policy goal that still needs to be achieved by the EU.

The data suggests that there is a challenge in the amount of political support for intermodal transportation. While there seems to be a good amount of support, it seems

to be selective support. This means that support is not institutionalized but is of individual nature and comes support from people that understand and support them. Because of this, there is no real big push for the technology. These results are in line with (Macharis & Pekin, 2009), which states that it would be helpful to have a more integrated policy approach to create a model shift from barge to rail. Data suggests that a serious traffic policy is required that must pursue this in an active manner. At the moment, the data suggests that it is only done on a communal level, which resembles a patchwork. The results also might suggest that the findings by (Tsekeris, 2011), that public expenditure to promote interconnectivity and interoperability between urban public transport and nonroad could strengthen intermodal transportation, are worth further looking into.

The data suggests that there are imbalances between laws that regulate traffic conditions on the road and on the rail. There seems to be more regulation for operations on rail, which includes the laws governing the drivers. At present, the results suggest that the road is not operating in a realistic cost structure. If companies operating on the road, would be forced to operate in a realistic cost picture, then the situation for rail would increase. These findings support the theory by (Macharis & Pekin, 2009), which acknowledges that intermodal transport has certain difficulties in competing with unimodal transport. However, the results contradict the claims of (Macharis & Pekin, 2009) that this is a problem that mostly presents itself over short distances. The data instead suggest that this is true for all distances and legislation could improve the competitive situation for intermodal transportation regardless of distance.

Another challenge is the capacity for reserving routes. Data suggest that registering routes needs to be done 15 months in advance. to run their trains. This restricts flexibility. These results add to the hypothesis by (Kumar & Anbanandam, 2020b), that limited rail infrastructure in remote locations restricts the flexibility of the rail mode. The results present evidence that flexibility is not just restricted due to remote locations but also due to the long process of registering routes.

The results suggest that the EU should look at Switzerland since they support terminals in other countries and also have operator support. Intermodal transportation is being supported by the Swiss Ministry of Transportation. Switzerland also supports strategically important projects with other types of support programs. These results confirm the hypothesis of (Macharis & Pekin, 2009), which states that policy measures that would help strengthen intermodal transportation could be directed towards

reducing the high fixed costs, as well as provide support for the building of new terminals or increase support for the already existing ones.

5.2.2 Infrastructure and technology

The data indicates that a challenge in infrastructure and technology of intermodal transportation lies in the fact that traffic flows can change at any point and the terminals that have already been built cannot be moved anymore. Therefore, attempts are made to create a terminal system that doesn't require a terminal platform anymore. The results are contrary to the claims of (Konings, 1996) that the growth of intermodal transport can threaten the accessibility of the terminal in which mode changes are happening. It rather seems that the accessibility of the terminals is being impacted by changing traffic flows rather than an increase in intermodal transportation. The results, however, support the claims by (Konings, 1996) that cost savings and quality improvements in handling systems must be developed.

Another challenge, according to the data, comes from financial restrictions that impact the number of investments**,** the strength of the terminal network, and the number of wagons. Building terminals cost a lot of money and it takes time before they establish themselves. But once this is done it will create a network effect where forwarders will not be able to pass this. The number and locations of the terminals determine the position in the market. They provide further evidence to the claims by (Rodrigue, 2006) that challenges to intermodal transportation present themselves in the form of automated terminals, information systems, efficiency and reliability, and potentially new opportunities. The results indicate that potential new opportunities and automated terminals that operate on a high level, require huge investments, and take time to become profitable. Therefore, the financial side needs to be further highlighted when discussing the technological challenges to intermodal transportation. The results also contradict the claims by (Konings, 1996) that automation can be expensive and might not be worth the investment. The results clearly indicate that automation does help to strengthen the terminal network and make it unavoidable to forwarders. Therefore, it should be done, and the central point of focus rather revolves around the question of how to finance it.

Another challenge is to secure the locations. The data suggests that it is important to find the right locations and select the right terminals. In order to finance these projects, shareholders willing to support this strategy need to be found. This would make it possible to build multiple terminals and look for locations at the same time. The results

provide further evidence to the claim by (Yamada, et al., 2009) that models need to be created to find optimal solutions for the location of terminals. But the role of shareholders has been previously overlooked and due to their important role, they should be included when talking about the strategy work of finding the right locations.

According to the data, there is currently not enough economical support or political support for developing a strong terminal network. There is support from the EU program Connecting Europe and other national federal programs. But the support is not as good as in Switzerland, where the Federal Office of Transport (BAV) supports infrastructure facilities if trains drive through Switzerland. The results confirm the hypothesis by (Konings, 1996) and (Yamada, et al., 2009) that intermodal transportation faces several shortcomings that are connected to the existing infrastructure and technologies not being optimally developed to ensure well-coordinated and efficient multimodal operations. New terminals need to be built or the existing ones need to be improved to strengthen the intermodal transportation, which as the results indicated, is not being prioritized enough in the EU and could be improved.

5.2.3 Competition

One possible competition was identified as state train companies. But the results have shown that in reality companies in intermodal transport don`t see it as competition because it does not serve the market properly. This has been exemplified by the French system Lore that serves up to two routes and three trains per day. The results contradict the claims by (Saeedi, et al., 2017) that it is difficult to estimate the capacity of each transport operator along different routes. By looking closely, it is possible to estimate the capacity of transport operators and judge whether their operator model can transport a significant amount of cargo.

The data suggests that multiple attempts of intermodal transportation never prevail on a larger scale because the loading time is too long. Therefore, they are not generating profit because times are not competitive. These attempts are not seen as competition because they are not fully automated and don`t scratch the surface of the market with the volume that they can move. This is in line with the hypothesis of (Reis, 2014) that performance relies on doing well in several critical criteria including freight rates, carrier considerations, transit time, shipper market considerations, and safety. Because many attempted solutions have a transit time that is too long, they fail this criterion and are not viable solutions for the mass-scale movement of cargo. The results also confirm the

hypothesis by (Kreutzberger, 2008) that vehicle time generates vehicle time costs. When an attempt takes too much time it generates too much cost, which makes the attempt not competitive.

The results have shown that the biggest challenge to intermodal transportation comes from its main competition, which is the road. This is due to the costs that are being paid there. Therefore, intermodal companies must convince forwarders to switch to the road. This is attempted by offering a product in a price-sensitive market that is a little cheaper. Another factor is the location of the terminals. This determines the kind of competition that intermodal transportation is faced with. The results confirm the findings by (Saeedi, et al., 2017) that there are many truck companies that offer their service at the terminals in Rotterdam. Therefore, intermodal transportation must be able to compete with them there. This also confirms findings by (Kreutzberger, 2008) that intermodal transportation must be competitive regarding both costs and time. It also confirms findings by (Reis, 2014) that in most scenarios there was little reason to choose intermodal transportation. Therefore, companies in intermodal transport must intensify their efforts to deliver reason to make the switch from road to rail.

The data suggests that when customers start demanding that companies like Amazon are doing something for sustainability, this will pressure forwarders to do something. At the moment, nobody is looking at the supply chain and nobody thinks about how much CO2 emissions were created through transportation. If there is going to be a massive change in the awareness about this in society. The results contradict the claims of (Lim & Thill, 2008) that intermodal transportation will only be economically viable if a reduction of the generalized impedance on modal segments offsets the higher costs. Instead, it will be economically viable if there is an attitude change in the population that puts pressure on big companies to make changes to their supply chains.

5.3 Ways to tackle the challenges and address inhibitors

In this part, I present the strategies that are being used to tackle the challenges and address the inhibitors.

5.3.1 Cost analysis

The results indicate that the company is cost-based. The strategy is to have the costs be reimbursed per route in relation to the project. They have different segments that need to be addressed. Including the wagons, the terminal area, and intermodal operations

which is the entity that is in contact with customers and sells the services. The intermodal operations generate outside revenues. The EVUs are the biggest cost block and make up 70% of their costs. The results provide numbers to the cost model by (Janic, 2008), which showed how one can calculate the costs of intermodal transportation. The results show that the internal handling costs make up the biggest cost block.

The results show that the prices must be competitive to road prices. Potential customers always compare the prices of intermodal transportation with the competition. The road prices are at 50, 60, or 70 cents in Eastern Europe and up to 1,20 € in Western Europe. Based on that, prices are set so that traveling by train is not more expensive than driving on the road. The aim is ultimately for revenue to exceed the costs. The results might suggest that the debate mentioned by (Kurtulus & Cetin, 2020) whether increases in the cost of road transport are more significant than reducing the cost of intermodal transport, should lean in favor of increasing road process to give a more realistic cost picture. This is particularly true for prices in Eastern Europe. Accomplishing this should make it a lot easier for intermodal transportation to be competitive. Therefore, the results confirm the hypothesis of (Kim & Wee, 2011) that adding taxes seems to be the most effective policy to increase the intermodal mode share. Measures such as reducing drayage and terminal cost are not significant.

Results suggest that the topic of sustainability is something everybody talks about it, but nobody wants to pay a higher price for it. Therefore, intermodal transportation must be competitive to the road and this cost pressure creates difficulties. Due to dumping prices in Eastern Europe, it makes road prices almost unbeatable there and this is unlikely to change. Therefore, companies involved in intermodal transportation must find the right routes where the rail is competitive. On these routes, they can scale up and use the advantage of lower transaction costs. The results confirm the hypothesis of (Arnold, et al., 2004) that the transportation industry does not focus on the environmental advantages of intermodal transport systems. It also confirms the hypothesis that economic competitiveness is still the main deciding factor.

5.3.2 Optimization and improvements

The data shows that the strategy is to be operating up to 20 own terminals, on up to 40 own routes, with up to 8000 own wagons, and generating a turnover of over one billion euro. At the moment, they are working on the Core Network Europe plan. That network includes the first three terminals, which are in Calais, Germany, and Northern Italy. They

will operate the routes Calais-Domodossola, Calais-Kaldenkirchen, Calais and Southern France. The results show that there is an opportunity here to introduce a goal programming model proposed by (Yang, et al., 2011), which aims to achieve an optimized intermodal network. Since there are many more factors to consider in the process of choosing the locations of terminals and routes such as political support, a mathematical model, could help to convince policymakers to give their support to a terminal to strengthen intermodal transportation.

The strategy currently revolves to further develop the main route between Kaldenkirchen-Domodossola. Simultaneously, the strategy is to continue with their efforts regarding Lithuania. Afterward, there are plans to look at routes to Scandinavia, Southeast Europe, and Turkey. The long-term the strategy includes looking for markets outside of Europe. The entire Russian market and the Chinese market with the new silk road that is being built is interesting to them. This result might suggest that the tool proposed by (Liao, 2017), which is called vehicle route panning (DVRP), would be helpful in dealing with the demands of having many routes and a high number of real-time demands. This could help in managing many different routes.

Another strategy is to build terminals that are automated and have a high throughput. Results show that the model with high-frequency terminals would be able to almost triple the capacities compared to the classic combined traffic. This would be massively attractive for customers. They can achieve cheaper unit costs through high frequency, cheaper transaction costs, and they believe that they will be the better alternative regarding costs. The speed is making the business profitable. The results provide evidence to the claim of (Trip & Bontekoning, 2002) that new-generation terminals are able to integrate small flows into the intermodal system. New terminals should enable the intermodal system to be competitive over shorter distances due to lower costs and higher speed. Of course, this will need to be proven once all the terminals are operating.

On problem is that middle-sized companies do not have enough to transport to make it financial sense to order an entire train and instead hire a truck. That is why it would be helpful to have a tool called KMU. The companies can go online and see if there is empty space on a train. Results have shown that DB already has something like this. These results confirm the hypothesis by (Baykasoglu & Subulan, 2016) that load planning is important to reduce costs. It also provides further evidence that it would be useful to have a mixed-integer mathematical programming model, to solve load planning or intermodal freight transportation planning problems.

5.3.3 Other strategies

Apart from the strategies previously mentioned, the data has shown that there are other strategies that are being employed in intermodal transportation, which have so far generated less attention in the literature but should be taken into account. Based on the data, other strategies that are being used to tackle the challenges and address inhibitors include partnering and working together with other companies such as train transportation companies. This includes sharing projects such as accessing the technical conditions of a new route and optimizing parameter. By having close cooperation with local partners, one company doesn`t have to do everything by themselves, which saves time and resources. Other partners include EVUs, terminal partner, local politics, and the local population. They also work a lot with the authorities to get approvals.

Another strategy is to conduct testing. The data shows that there is always one or two years of testing being done on every respective route. This is done to check out all difficulties. Testing is being conducted by using pilot trains and simulate all real customers in order to detect all difficulties. The strategy is to test piece by piece and reduce all problems in coordination with partners.

The results show that another important strategy is to have strong patent protection. In the past, there were companies that tried to copy the technology. Therefore, patent protection is extremely important to ensure legal protection for the technology used in the field of intermodal transportation.

Results have shown that another strategy is to bundle knowledge and acquire relevant information. When making strategic decisions the executive board and the supervisory board come together. Members in the executive board and members on the supervisory board discuss strategic decisions and bundle knowledge to acquire a full understanding of the market. Data has shown that it is extremely important to understand out of which reason a customer is putting a trailer onto rail and most importantly why not. By involving multiple members, the company aims to gather all knowledge and possess sufficient information to make the best decision possible. If there is additional knowledge needed, the company tries to get specialists that have been involved in the project for a long time. All of this is being done because strategic decisions require full knowledge of rail transportation, technical knowledge, and political knowledge. This approach has been supported by data from Nikrasa. According to the data, a strategy that is used by Nikrasa is to introduce a big project, when encountering a big challenge. They

conduct project management with a high amount of subject knowledge. This requires in-depth knowledge about the subject and the details.

A strategy that was emphasized during the COVID-19 pandemic, was to strengthen communication to get the point across that the product is interesting for everybody. By communicating effectively to the customers and being flexible in what to transport, it was possible to run trains at full capacity during the entire pandemic.

5.4 Contribution statement

By conducting this research, I gathered new data from two previously understudied companies that contribute to the literature. My research provides further support for:

- the studies by Vis & Carlo (2010) and Garehgozli, et al. (2015) as well as Lai, et al. (2008b) in regards to operational challenges.

- the studies by Luo, et al., (2016), Tawfik & Limbourg (2019), Li & Tayur (2005), Ricci & Black (2005), Holmberg, et al. (1998) as well as Newman & Yano (2000), all regarding organizational challenges.

- the hypothesis by Kumar & Anbanandam (2020b), Tsamboulas, et al. (2007) and Macharis & Pekin (2009) regarding legislation.

- the studies by Yamada, et al. (2009) and also Rodrigue (2006) regarding infrastrucutre and technology.

- the studies by Reis (2014) as well as Kreutzberger (2008) regarding competition.

- the studies by Arnold, et al. (2004) as well as Kim & Wee (2011) regarding cost analysis.

- the studies by Trip & Bontekoning (2002) and also Baykasoglu & Subulan (2016) in regards to optimization.

My research has contributed data that has resulted in the rejection of the findings of Nossack, et al. (2018) regarding operational challenges. The results are also conflicting with the study by Faturechi & Miller-Hooks (2014) regarding external challenges. The research contributes data that contradicts two claims by Konings (1996) regarding

infrastructure and technology. The research contributes results that contradict the studies by Saeedi, et al. (2017) and Lim & Thill (2008) about competition.

This study has also contributed data:

- that builds on existing findings by Chen & Miller-Hooks (2012) regarding external challenges.

- to expand the study by Kumar & Anbanandam (2020b) regarding legislation.

- to the model by Janic (2008) in the field of cost analysis.

- to settle the debate mentioned by Kurtulus & Cetin (2020).

- that strengthens the argument for looking further into the model proposed by Yang, et al. (2011) as well as another model by Liao (2017), which are both dealing with optimization.

The present study also delivers contributions that are not based on existing literature. These contributions involve new strategies to tackle challenges. These include partnering up with other companies and authorities to share resources and save time. Strong patent protection to avoid other companies from copying new technology. Testing the routes to detect any problems and complications and fix them before scheduling regular trains. Bundling knowledge in the company and acquiring specialist knowledge from outside in order to maximize expertise and be seen by others as extremely competent. Strengthening communication to customers to assure them that the service provided would be helpful for them as well as ease any concerns that might be present.

5.5 Implications for other companies

Based on my findings, my suggestions for other companies in the field of intermodal transportation are to clearly communicate to terminal operators how long their loading times are and ease concerns about new technologies increasing times. This could help to reduce apprehension from the operators and encourage them to include intermodal transportation in their plannings. Companies should also keep in mind that just as (Li & Tayur, 2005) stated customer selects a service not just based on the price, but also based

on their evaluation of this service. Therefore, emphasis must be placed on making sure that the service is high quality to be an attractive alternative to road transport.

Additionally, companies should invest to develop cost savings and quality improvements in handling systems. They also should try to achieve as much automation as possible since this helps to strengthen the terminal network and improve competitiveness. Lastly, companies should try to communicate their role in decreasing emissions to the consumers. If consumers start to pay attention to the role of supply chains in overall greenhouse gas emissions, it will put pressure on big companies to choose more environmentally friendly transport. This would then strengthen the competitive position of intermodal transportation.

5.6 Implications for policymakers

Based on my findings, my suggestions for policymakers to tackle the challenges that companies in intermodal transportation are faced with, are to have a look at the train regulation law EREGG and figure out how to strengthen it. If this is not possible, policymakers create new legislation that is able to stop cross-financing. Additionally, policymakers should intensify their efforts to achieve the liberalizations of the rail cargo market in Europe, since this is a major obstacle to intermodal transportation.

Furthermore, there are currently major issues with the system in place to register routes. Policymakers should therefore implement an improved system that allows for more flexibility. This would contribute to improving the competitiveness of intermodal transportation in comparison with the road. Policymakers in the EU should also take a closer look at the situation in Switzerland and try to emulate some of the policies there that help intermodal transportation such as providing support for the building of new terminals and the various support programs for companies in the field.

5.7 Recommendations for further research

When searching for literature for this thesis, I recognized the lack of literature regarding possible strategies to advance intermodal transportation. The only strategies that I could find were cost analysis and optimization. Through my work on this thesis, I found strategies that included testing, working with partners, communication, and patent protection. I am optimistic that there are other possible strategies and would recommend conducting further research into this matter to identify them.

While researching this topic, I also found that there was no research on what kind of role subsidies play in impacting the competitiveness of companies in intermodal transportation. Likewise, there was no research about the role that state financing plays in the competitiveness of state-owned companies. Further research could examine this. Additionally, further research into the impact of a toll on the choice of transportation method should be conducted to help policymakers to craft effective legislation. This could help solve the debate described by (Kurtulus & Cetin, 2020) on whether it is better to increase road prices or lower the prices of intermodal transportation.

5.8 Limitations

There are multiple things to be considered that impact the generalizability of this research and thereby limit the research.

The sample of this thesis only included two companies. It is, therefore, entirely possible that the situation looks different when researching other companies. The implications drawn from the research are also only from those two companies, which may give a distorted look at the situation in the field of intermodal transportation as a whole. Furthermore, I had to rely on online interviews due to the ongoing pandemic, which might have impacted the willingness of interviewees to share as much information as in in-person interviews.

Furthermore, the interviewees are aware that their answers will be used to write a thesis that is publicly available and the company names are not anonymized. Therefore, they might have been hesitant to reveal any insight information regarding their companies and be wary not to reveal anything sensitive. As a result, the answers might provide a more optimistic picture of the situation of the companies since the participants might want to present the companies in a better light.

5.9 Concluding remarks

In this thesis, I have followed the research aim to explore the biggest challenges to implementing an intermodular road to rail system and how they can be tackled. This was done by answering the research questions: What are the biggest challenges to implementing an intermodular road to rail system and what are possible ways to tackle the different challenges and thereby increase the usage of intermodal transportation?

By studying two case companies, that have not been studied in this context before, I managed to generate new data to help achieve my research aim. The results show that

the biggest challenges to the intermodal system originate from the areas of operational challenges due to terminal operators not being familiar with new technologies. This might be addressed in the future by building their own terminals. It will, however, take a long time and requires massive resources. Another big challenge comes from having to be competitive to dumping prices on the road that are frequently so low that intermodal transportation does not stand a chance. Lastly, a big challenge is the lack of discourse in the public about the crucial role of supply chains in the emission of greenhouse gasses and as a result, there is little pressure on companies to address this.

As for the question of how to tackle the challenges, the results show that an important strategy is to create partnerships between different companies operating in the intermodal sector. This helps significantly with strengthening the competitive situation of all companies involved. The second very important strategy is to bundle knowledge and acquire relevant information and seek specialist knowledge when required. This helps to make the best possible decisions and increases the chance of success. The third strategy to increase the usage of intermodal transportation is to effectively communicate to customers and highlight the advantages of the business model. This increases awareness of potential benefits and helps to ease possible concerns. This strategy is of particular importance in the as of this moment COVID-19 pandemic.

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APPENDIX 1 INTERVIEW GUIDE

1. What is the difference between CB and previous technologies?
2. Could you describe the business model of CB?
3. What are the plans for the next couple of years?
4. What are the biggest advantages of using the technology by CB?
5. Is it possible to improve the technology even further?
6. What other companies or entities is CB working with?
7. Is CB receiving support from an entity and in what form?
8. How are the costs of the technology being calculated?
9. What are the disadvantages of CB?
10. What obstacles are in the way of implementing it further?
11. Who are the market incumbents and biggest competitors?
12. Is there resistance towards CB and from which stakeholders is it coming from?
13. What policies or legislations would be beneficial for CB?
14. Is there political support for CB?
15. What strategies are CB using to address obstacles and other challenges?
16. Can you give examples of CB using strategies to successfully overcoming challenges?
17. What type of resources would help CB to achieve more in the current environment?
18. Anything else you would like to say, or add?